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PHYSICS ABSTRACTS

SECTION A

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SCIENCE ABSTRACTS

SECTION A, PHYSICS
SECTION B, ELECTRICAL ENGINEERING

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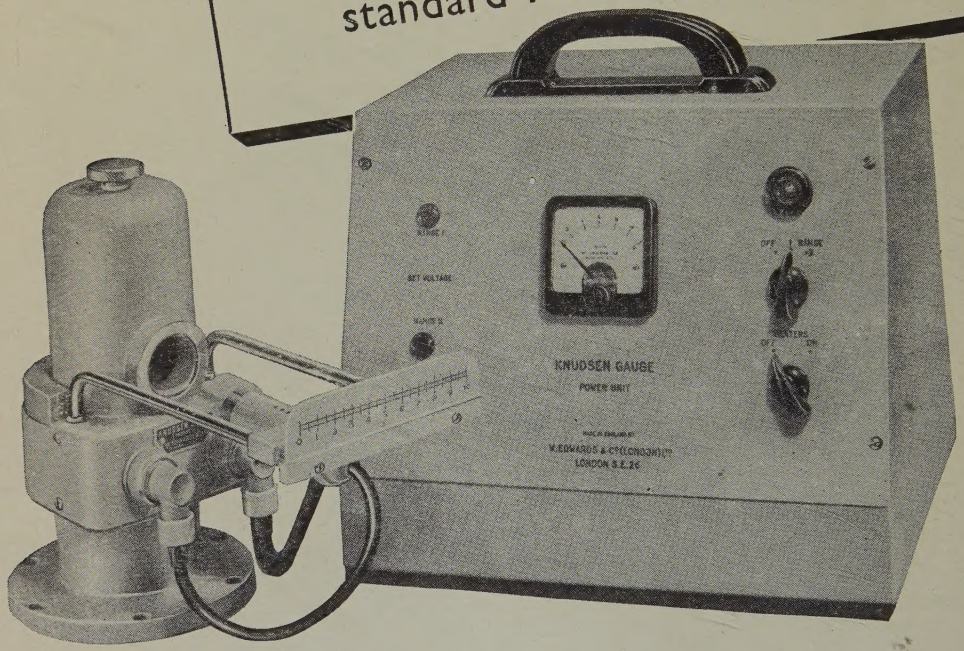

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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

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Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

LIST OF JOURNALS

The following list together with the lists published in the proceeding issues of the current volume, supplements the List of Journals published with the January number of Volume 53 (1950) and the Supplements published with the Indexes to Volume 53 (1950) and Volume 54 (1951). Reprints of the List of Journals (1950) and the Supplements (1950, 1951) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Journals marked * are not received regularly.

**Fra Fys. Verden*	*Fra Fysikkens Verden.* Oslo.
Mem. Fac. Sci. Kyusyu Univ.	*Memoirs of the Faculty of Science of Kyusyu University,* Hukuoka. [Correction of earlier entry.]
Mem. Fac. Techn. Tokyo Metrop. Univ.	*Memoirs of the Faculty of Technology of Tokyo Metropolitan University.* Tokyo.
Czechoslovak Math. J.	*Czechoslovak Mathematical Journal.* Ústřední ústav matematický, Loretánske námestí č. 3, Prague IV.

Change of Title

Čas. Pěst. Mat. Fis.	*Časopis pro Pěstování Matematiky.* Title changed to Czechoslovak Mathematical Journal [Czechoslovak Math. J.] owing to separation of mathematics and physics into separate journals as from end of Vol. 75, 1950. The first issue appears as Vol. 1(76), No. 1, 1951.

Change of Address

J. Televis. Soc.	*Journal of the Television Society.* 164, Shaftesbury Avenue, London, W.C.2.

Errata

Abstr. 5621 (1951), line 2: *insert* L. HALPERN as second author.

Author Index (1951), p. 1216, column 1: *insert* HALPERN, L. *See* KOCH, K. M.

Author Index (1951), p. 1234, column 1, line 12: *insert* KOCH, K. M., and HALPERN, L., as authors of entry for Abstr. 5621.

Author Index (1951), p. 1263, column 2: *for* PERKINS, J. F., and SOLBERG, A. W., JR, *read* PERKINS, J. F., and SOLBRIG, A. W., JR; p. 1285, column 1: *for* SOLBERG, A. W., JR, *read* SOLBRIG, A. W., JR.

Abstr. 1703 (1952), line 8: *for* Rl *read* Rh.

Abstr. 3113 (1952), line 3: for (*July–Sept.*, 1951) *read* (*July–Dec.*, 1951).

Corrections to Articles

Corrections have been published, as shown below, to the articles whose Abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 361 (1952): **20,** 537 (*March*, 1952).

Abstr. 9332 (1951): **10,** 200 (No. 3, 1952).

MATHEMATICS 51

512.394 : 621–526

3197. A method for evaluating the roots of quartic equations and its application in servomechanism theory. A. PORTER. *Selected Government Research Reports, Vol. 5. "Servomechanisms," London, Department of Scientific and Industrial Research* (1951) 77–84.

Methods of analysis of servomechanism performance are discussed and a method for the numerical solution of quartic equations involved in such analysis is presented. A.

512.9

3198. Physical components of a tensor. I. BRAUN. Letter in *Bull. Res. Coun. Israel*, **1**, 127 (*March*, 1951).

The substitution of "physical components" of tensors in Reiner's equation [*Amer. J. Math.*, **67**, 350 (1945)] does not alter its form. J. E. CAFFYN

517.566

3199. Relations between delta functions. B. GROSS AND H. PELZER. *Proc. Roy. Soc. A*, **210**, 434–7 (*Jan.* 7, 1952).

From a physical argument a relation between the two δ functions $\delta(x-d)$ and $\delta(x-b)$ was conjectured which has been found useful. The procedure does not comply with rigorous mathematical standards, but verifications of this relation are given for two different special representations of the δ function, illustrating how the procedure is understood. A.

517.9

3200. On the accumulation of errors in the numerical solution of differential equations. A. PAPOULIS. *J. Appl. Phys.*, **23**, 173–6 (*Feb.*, 1952).

The following gives a method for the evaluation of errors in the numerical solution of systems of differential equations. Under certain assumptions the errors can be obtained by finding the difference $r(x)$ between the computed solution $y(x)$ passing through the given initial point, and the solution $Y(x)$ passing through a neighbouring point—that is, by solving the same equations repeatedly with different initial conditions. A.

517.93

3201. The reversion method for solving nonlinear differential equations. L. A. PIPES. *J. Appl. Phys.*, **23**, 202–7 (*Feb.*, 1952).

The method is based on the algebraic procedure used in reverting power series. By the use of this method, ordinary differential equations having certain type of non-linearity are reduced to systems of linear differential equations. The resulting linear differential equations are then solved by the Laplace transform or operational method. The general procedure is illustrated by means of examples, and the method is applied to non-linear electric circuits. A.

517.947

3202. An iterative method for the solution of eigenvalue problems. V. J. BERRY AND C. R. DE PRIMA. *J. Appl. Phys.*, **23**, 195–8 (*Feb.*, 1952).

A simple iterative procedure is developed for the determination of eigenvalues and eigenfunctions associated with the solution of Sturm–Liouville problems in a finite interval. Both the frequency and the displacement for a given mode may be determined with an accuracy which is independent of the accuracy involved in the calculation of other modes. Convergence of the iteration process is rapid, and the successive approximations to a given eigenvalue are shown to form a monotone sequence. The method is particularly useful when the coefficients of the differential equation are not expressed in analytical form. A.

517.947 : 531.252

3203. The relaxation method in stress analysis. D. G. CHRISTOPHERSON. *Brit. J. Appl. Phys.*, **3**, 65–72 (*March*, 1952).

Discusses various proposals which have been made to accelerate the convergence of the relaxation method as applied to the solution of some of the well-known differential equations of physics and engineering. It is shown that a very high accuracy can easily be achieved in simple cases where the differential equation is the second order. In the case of the biharmonic (fourth-order) equation, which occurs in the analysis of plane stress and plane strain, a method is proposed by which, in suitable cases, a high accuracy can be achieved by employing two second-order equations successively. It is suggested that where this can be done a given accuracy can be achieved with relatively little labour, though it is recognized that the method proposed has only a limited application. A.

518.2 : 517.564.3

3204. Tables of the Bessel functions of the first kind of orders seventy-nine through one hundred thirty-five. [STAFF OF THE COMPUTATION LABORATORY.] *Annals of the Computation Laboratory of Harvard University, Volume XIV. Cambridge, Mass., Harvard University Press; London, Geoffrey Cumberlege* (1951) 614 *pp.*

518.42

3205. Cylindrical and rotational coordinate systems. P. MOON AND D. E. SPENCER. *J. Franklin Inst.*, **252**, 327–44 (*Oct.*, 1951).

The z-plane map, $z = f(w)$, is regarded as a new co-ordinate system, and is made into a cylindrical or rotational system by translation or rotation. Solutions of the Laplace, Helmholtz, wave and diffusion equations are obtained in these co-ordinate systems when separation of the variables is possible. A classification of the various cases is carried out.

L. S. GODDARD

518.5 : 621.318.572 : 621.317.727

3206. Three dimensional electrical potential analyser. V. E. GOUGH; S. C. REDSHAW. Letters in *Brit. J. Appl. Phys.*, **3**, 58 (*Feb.* 1, 1952).

The paper of Abstr. 12 (1952) is referred to and the number of tiers in the resistance frame and an implied restriction of use queried. Redshaw replies that there are 9 actual tiers, and that the method is also applicable to 3-dimensional models, using a defined tier as a master, possibly with additional resistance tiers.

E. H. W. BANNER

518.5 : 621.392 : 621.317.79

3207. An electrical network for determining the roots of a polynomial. A. MANY. Letter in *Bull. Res. Coun. Israel*, **1**, 108–10 (*Aug.*, 1951).

The cathode-follower multiplier and adder may be simply adapted to provide the required analogue conditions. A 3-stage circuit for a 3rd-order polynomial is given, balance being achieved by varying a set of ganged potentiometers for null indication: the particular root may then be read off directly. Complex coefficients can also be handled by adding condensers. Accuracy is 1%. A. J. KENNEDY

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.615 : 523.842

3208. A photoelectric method of measuring double stars. P. LACROUTE AND P. BACCHUS. *C.R. Acad. Sci.* [*Paris*] **234**, 408–10 (*Jan.* 21, 1952) *In French.*

An objective method is proposed in which the light from the stellar image is modulated by a moving "grid" diaphragm placed close to the focal plane of the telescope. The two component star-images will produce two out-of-phase photocurrents in the receiver with resultant amplitude given by

$$i = i_0[\sqrt{(1 + K^2 + 2K \cos \pi l/p)}](l + K),$$

l being the separation of the star-images, projected in a direction perpendicular to the slots of the grids; i_0, the current output for a single star of brightness equal to that of the double star; K, the ratio of brightnesses of the two component stars; and $2p$, the spacing of the grid. D. R. BARBER

522.615 : 535.247.4 : 621.383 : 621.317.39

3209. Developments in the practical use of photocells for measuring faint light. G. E. KRON. *Astrophys. J.*, **115**, 1–13 (*Jan.*, 1952).

Infrared-sensitive emission photocells do not operate with high efficiency in an electronic tube amplifier unless a grid resistor of at least $2{\cdot}5 \times 10^{13}\ \Omega$ is used or unless the gas-multiplying factor of the cell can be made large without sacrificing stability. A method for practicable use of grid resistors at least as high as $5{\cdot}0 \times 10^{13}\ \Omega$ is given. In addition, a method is given for making photocells operate stably with high gas multiplication. The material in this paper may be used as the basis for design of an astronomical photoelectric photometer for use in spectral regions, including the near infrared. The photometer will have satisfactory linearity over large brightness ratios, and it will perform on faint light as efficiently and as usefully for astronomical purposes as an equivalent system using a multiplier phototube. A.

523.165

3210. Extra-galactic radio-frequency radiation. R. H. BROWN AND C. HAZARD. *Phil. Mag.*, **43**, 137–52 (*Feb.*, 1952).

It has been shown previously that radio-frequency radiation is being received on the earth from the extra-galactic nebula N.G.C. 224 (M. 31). This paper reports some initial attempts to extend the measurements of extra-galactic radio radiation on a wavelength of 1·89 m. A radio survey has been made of 3 bright nebulae (in addition to N.G.C. 224) and 3 radio sources have been associated with them. The radio intensity to be expected from 8 of the major clusters of nebulae has been calculated and 2 of the clusters have been surveyed and identified with radio sources. For a selected region of sky an attempt has been made to predict the irregularities in the radio isophotes corresponding to large-scale irregularities in the distribution of extra-galactic nebulae. These predictions have been compared with radio observations of the region, and it is shown that there is a correlation between the radio isophotes and the distribution of extra-galactic nebulae. A preliminary examination has been made of the relation between the apparent photographic magnitude and the apparent radio magnitude of nebulae. The results suggest that there is a definite relationship and that the apparent photographic magnitude increases more rapidly than the apparent radio magnitude. A.

523.165 : 537.591.1

3211. Generation of ultra-radiation in stellar electromagnetic fields. A. SCHLUTER. *Z. Naturforsch*, **7a**, 136–40 (*Jan.*, 1952) *In German.*

523.5

3212. The physical theory of meteors. II. Astroballistic heat transfer. R. N. THOMAS AND F. L. WHIPPLE. *Astrophys. J.*, **114**, 448–65 (*Nov.*, 1951).

Previous difficulty in formulating a quantitative physical theory of meteors has in large part originated from the wide gap between terrestrial experiments and meteor observations. The physical theory of meteors falls into three aspects: air resistance, heat transfer, and radiation. This paper summarizes an attempt to analyse the heat-transfer aspect from the standpoint of the available meteor data and of some recent laboratory experiments. The section that relates to the laboratory experiments represents the first published attempt to measure heat transfer to bodies in free flight when the velocity is so high that ablation occurs—thus defining the astroballistic region. The free-flight heat transfer in the astroballistic region appears from these experiments to vary with velocity and air density according to the meteor formula rather than according to the conventional aerodynamic formulae established at lower velocities. The heat-transfer efficiency, expressed in terms of that to a Newtonian putty ball, is about 1% in the region near 1–2 km/sec. The meteor results show considerable scatter in values of the heat-transfer efficiency, with no obvious dependence upon velocity or air density and with a favoured estimate lying near 5%. A possible interpretation of the scatter of meteor values lies in the fragmenting and flaring of meteors; and the great importance of further study on this point is emphasized. Some considerations on the maximum-sized meteorite capable of surviving intact lead to an independent gross estimate of the heat-transfer efficiency. An attempt is made to interpret the deep pitting observed

in some meteorites in terms of enhanced ablation on an initially irregular surface, in accordance with some additional free-flight experiments. A.

523.53

3213. Characteristics of radio echoes from meteor trails. III. The behaviour of the electron trails after formation. J. S. GREENHOW. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 169–81 (*March*, 1952).

Deals with the durations and amplitudes of the radio echoes reflected from meteor trails. For wavelengths of 4·2 and 8·4 m the durations of most echoes are shown to be very nearly proportional to the square of the wavelength, as predicted by simple diffusion theory. It is suggested that long duration meteor echoes are due to total reflection from trails of very high electron density, and it is shown that the amplitudes of these echoes would only be of the same order as the amplitudes of the short duration echoes from trails of low electron density. Further evidence is given to show that the amplitude fluctuations in the radio echoes are caused by distortion of the column of ionization, relative motion of several reflecting centres due to wind turbulence producing changing interference conditions. Turbulent winds of the order of 20 m/sec are inferred at altitudes of 80 to 100 km. [For Pt I, see Abstr. 2309 (1948). Pt II not yet published.] A.

523.6

3214. The influence of the sun on the brightness of comets. M. BEYER. *Naturwissenschaften*, **39**, 13–17 (*No.* 1, 1952) *In German.*

The physical changes accompanying a comet's near approach to the sun are discussed; and the observed fluctuations of brightness are shown (for comet 1939d) to be correlated positively with the Zurich rel. sunspot number. D. R. BARBER

523.663

3215. The tail of Halley's Comet in 1910. L. BIERMANN. *Z. Naturforsch.*, **7a**, 127–36 (*Jan.*, 1952) *In German.*

The material of Bobrovnikoff's monograph [*Publ. Lick Obs.*, **17** (*Pt* 2, 1931)] is re-discussed in relation to solar and geomagnetic activity during April–May, 1910, with particular reference to the interaction of the ionized, gaseous tail-streamers, and solar corpuscular radiation. D. R. BARBER

523.673

3216. Comets' tails and solar corpuscular radiation. L. BIERMANN. *Z. Astrophys.*, **29**, 274–86 (*No.* 3, 1951) *In German.*

The high accelerations observed in comets' tails are attributed to the impact of streams of particles from the sun. The properties of such streams are deduced from the characteristics of geomagnetic storms, and are used in a theoretical discussion of the effects of their collision with the material of a comet. It is concluded that accelerations of the observed magnitude can be so produced, the impulse being transmitted almost entirely by free electrons of the stream. Some observational evidence of a connection between high accelerations in Comet Whipple–Fedtke (1942g) and geomagnetic storms is presented. M. W. OVENDEN

523.7

3217. Observation of the sun. A. BEHR AND H. SIEDENTOPF. *Naturwissenschaften*, **39**, 28–38 (*No.* 2, 1952) *In German.*

A description of the various phenomena (spots, faculae, chromospheric eruptions, coronal and r.f. emissions) associated with the solar cycle of activity, and methods of observing and collating the derived data. A list of 9 journals in which data are regularly published is included. D. R. BARBER

523.72

3218. The atmosphere of the sun. R. E. WILLIAMSON. *J. Roy. Astron. Soc. Can.*, **45**, 232–49 (*Nov.–Dec.*, 1951).

A summary is given of (*a*) the interpretation of limb darkening in terms of the absorption coefficient of the negative hydrogen ion, and (*b*) the detection and significance of radio radiations from the sun. M. W. OVENDEN

523.72

3219. Excess radio noise from solar flares and sunspots. R. Q. TWISS. *Nature* [*Lond.*] **169**, 185–6 (*Feb.* 2, 1952).

The idealized model of an ion-neutralized electron beam moving between two surfaces of discontinuity suggests a mechanism for amplification of the transverse radiation field, at a level in the sun from which it could escape. The existence of reflecting regions capable of providing such discontinuities in the solar atmosphere, and attenuation by electron-ion collisions, are briefly discussed. Drift velocities of 10^{-2} of the mean thermal velocities are shown to be sufficient. M. W. OVENDEN

523.75

3220. Solar eruptions visible in integrated light. R. MÜLLER. *Naturwissenschaften*, **38**, 545–6 (*No.* 23, 1951) *In German.*

Since Carrington's classical observation (1859) of a chromospheric eruption in integrated light, 4 other observations have been reported, viz. in 1937, 1946 (2) and 1948. The latter is here described in detail. D. R. BARBER

523.75

3221. The asymmetry of distribution of chromospheric eruptions. F. LINK AND J. KLECZEK. *Z. Astrophys.*, **29**, 304 (*No.* 3, 1951) *In French.*

Replying to a criticism of the authors' results by M. Waldmeier [see Abstr. 6964 (1950)] it is stated that the observed asymmetry can be explained only in terms of either an asymmetric curve of visibility of the eruptions, or of a terrestrial influence. D. R. BARBER

523.75

3222. Variability of the coronal temperature. M. WALDMEIER. *Z. Astrophys.*, **30**, 137–51 (*No.* 2, 1952) *In German.*

Ionization temps. of solar corona are computed from intensity ratios of coronal lines, 5 303 Å; 6 374 Å. Results are expressed as functions of heliographic lat., phase of sunspot cycle and distance from solar limb. The correlation with spot-cycle is most marked for polar regions where increase of temp. from spot min. to max. amounts to *c.* 50% (mean

$T = 5 \times 10^5$ °K). A chart of coronal isotherms within ±90° helio. lat. is shown for the 11 yr period, 1940–50. D. R. BARBER

523.752

3223. On the electron temperature of the chromosphere and prominences. D. KOELBLOED AND W. VELTMAN. *Proc. K. Ned. Akad. Wet. B*, **54**, 468–74 (*No.* 5, 1951).

The method proposed by Zanstra [Abstr. 813 (1951)] to obtain electron temperatures for the chromosphere makes use of the intensities of the Ba_c spectrum, the other recombination and electron switch spectra and the scattering of photospheric light by free electrons. With this method electron temperatures are derived for the chromosphere, using films taken by Davidson during the solar eclipse of January 14, 1926. For the electron temperature of the chromosphere a value of at most 10 000° to 16 000° is obtained. This is a good deal lower than the kinetic temperature of 30 000° found by Redman. For the prominences investigated an electron temperature of about 5 000° was obtained, while the concentration of electrons and protons seems higher than the mean values usually adopted. A.

523.752

3224. Turbulence and temperature of the solar chromosphere. A. UNSÖLD. *Z. Naturforsch.*, **7a**, 121–6 (*Jan.*, 1952) *In German.*

A review and theoretical discussion of data for reversing layer, middle and outer chromosphere derived from line-profile measures. Turbulent velocities of 12 km/sec (reversing layer) and 15 km/sec (mid- and outer-chromosphere) result. Temperatures from $T = 3\,800$°K (Fe lines) to $T = 30\,000$°K (He lines) are indicated with increasing height above photosphere. D. R. BARBER

523.752

3225. The limb flare of May 8, 1951. H. W. DODSON AND R. R. MCMATH. *Astrophys. J.*, **115**, 78–81 (*Jan.*, 1952).

This object rose to a height of 50 000 km in less than 90 sec. During this interval the Hα lines of the spectrum were 8–10 Å wide and showed large Doppler displacements. Throughout the remainder of the flare the change in height was negligible, and the Hα spectrum lines were 5–6 Å wide and symmetrical. This flare prominence was four times as bright as the undisturbed Hα disk, was accompanied by an increase in 200 Mc/s radiation from the sun and was associated with a sudden disturbance of the earth's ionosphere. A.

523.76

3226. A two-energy source solar model. I. EPSTEIN. *Astrophys. J.*, **114**, 438–42 (*Nov.*, 1951).

A model interior for the sun, in which the energy generation is governed by both the proton-proton reaction and the carbon cycle and in which the opacity depends on both photoelectric ionizations and electron scattering, is calculated by numerical methods. The equilibrium model has a H content (by weight) of $X = 0{\cdot}82$, a He content of $Y = 0{\cdot}17$, while the content of the heavier material is $Z = 0{\cdot}01$. The central temperature of this model is 15 000 000°, while its central density is 150. A convective core, if it exists at all in this model, cannot extend beyond 8% of the radiüs, nor can it include more than 5% of the mass. Only 30% or less of the total energy can be generated within such a core. The proton-proton reaction provides at least 95% of the energy production in this model. A.

523.77

3227. Measurements of the sun's general magnetic field. G. THIESSEN. Letter in *Nature* [*Lond.*] **169**, 147 (*Jan.* 26, 1952).

Recent photoelectric measures of Zeeman line-intensities in solar spectra made at ±45° heliographic latitude, indicate a negative dipole field of strength *c.* 2·5 gauss. D. R. BARBER

523.77 : 551.510.41

3228. The abundance of CO in the sun, and in the earth's atmosphere. L. GOLDBERG, R. R. MCMATH, O. C. MOHLER AND A. K. PEIRCE. Letter in *Phys. Rev.*, **85**, 481–2 (*Feb.* 1, 1952).

Dectection of CO in the i.r. solar spectrum [Abstr. 2376 (1952)] is confirmed by additional identifications of *c.* 100 lines between 23 000 and 24 000 Å. Preliminary estimates of CO solar abundance, and vibr. temperature give $N = 1{\cdot}1 \times 10^{19}$ mols/cm², and $T = 4\,300$°K. Observations of CO in earth's atmosphere above Mt. Wilson, California; Lake Angelus, Michigan; Columbus, Ohio; and Jungfraujoch, Switzerland, suggest that terrestrial distribution is highly localized. D. R. BARBER

523.774

3229. On the intensity of Ti lines at different points of the sun's radius. V. BAROCAS AND G. RIGHINI. *Astrophys. J.*, **114**, 443–7 (*Nov.*, 1951).

The equivalent width of eighteen medium-intensity Ti lines in the region λλ5210–4512 is measured at five different points of the sun's radius. A comparison between Fe and Ti lines shows that, whereas the Fe lines appear to decrease from the centre to the limb, the Ti lines reach a maximum at a point $\cos\theta = 0{\cdot}4$ approximately. A.

523.83 : 523.161

3230. The possible influence of interstellar clouds on stellar velocities. L. SPITZER, JR AND M. SCHWARZSCHILD. *Astrophys. J.*, **114**, 385–97 (*Nov.*, 1951).

Gravitational encounters between stars and interstellar clouds produce a much shorter relaxation time of the galaxy in the solar neighbourhood than do star-star encounters. This result is caused by the much larger masses of the interstellar clouds as compared with stars. In the extreme case that the largest cloud complexes acting as gravitational units should have masses of the order of a million solar masses, it is found that low-velocity stars may have been speeded up appreciably by star-cloud encounters during 3×10^9 years. This speed-up of the stars, which is the same for stars of all masses, arises from the tendency of the encounters to act toward equipartition of energy between clouds and stars, though at the present time equipartition must be far from reached. If the masses of the large cloud complexes are, in fact, high enough to make the star-cloud encounters sufficiently effective, one may suppose that all low-velocity population I stars have been formed

from interstellar clouds with initial average velocities equal to those of the present clouds and that the present differences in the velocity dispersions of population I stars have been caused entirely by star-cloud encounters. Under this assumption, the encounters would have increased the average velocity of older groups (late dwarfs and red giants) by about a factor of 2, while they would not have had time to affect the velocities of the younger stars (early main sequence). Even under extreme assumptions the star-cloud encounters are found to be incapable of changing noticeably the velocities of the fast population II stars. This may indicate that all population II stars were formed from the interstellar matter at an early stage, when the velocities of the primeval clouds were still high. A.

523.851.2

3231. The forms, orientations, and masses of globular clusters. H. M. JOHNSON. *Astrophys. J.*, **115**, 124–8 (*Jan.*, 1952).

Shapley's data on the apparent forms and orientations of globular clusters are used to test two new hypotheses about their spatial forms and orientations. The hypothesis that the equatorial planes of globular clusters pass through the galactic centre is shown to be consistent with the observations, and a physical interpretation is suggested. Cluster masses $\geqslant 4\times10^5\odot$ are also derived. A.

523.852.22

3232. The structure of the planetary nebula IC 418. O. C. WILSON AND L. H. ALLER. *Astrophys. J.*, **114**, 421–30 (*Nov.*, 1951).

Slitless Coudé spectrograms of the small, low-excitation, planetary nebula IC 418 are analysed to determine the intensity distribution across the disk in various monochromatic images. From an analysis of these intensity distributions an attempt is made to find the emission per unit volume. The emission in ergs/cm³/sec is expressed in c.g.s. units, and the approximate ionic densities of H, He, N II, O II O III, Ne III and S II are derived. A.

523.854

3233. The Milky Way from Sagittarius to Cepheus in the infrared. D. OSTERBROCK AND S. SHARPLESS. Note in *Astrophys. J.*, **115**, 140–1 (*Jan.*, 1952).

A wide-angle photograph is shown and discussed. It is compared with a photograph of the edge-on extra-gelactic nebula NGC 891; the similarity is striking.

523.854.1

3234. The theory of the fluctuations in brightness of the Milky Way. IV. G. MÜNCH AND S. CHANDRASEKHAR. *Astrophys. J.*, **115**, 94–102 (*Jan.*, 1952).

For Pt III, see Abstr. 8471 (1951). The integral equation governing the fluctuations is solved, quite generally, for the case when the system of the stars and clouds extends to infinity in the direction of the line of sight and the transparency factor, q, characterizing the clouds is governed by an arbitrary frequency function, $\psi(q)$ $(0 \leqslant q \leqslant 1)$. The solution is obtained in the form of a series in Laguerre polynomials with coefficients depending only on the moments of $\psi(q)$. It is further shown that the solutions found in Pt II [Abstr. 2345 (1951)] for two particular forms of $\psi(q)$ can be obtained as special cases of the general solution given here. A.

523.854.1

3235. The theory of the fluctuations in brightness of the Milky Way. V. S. CHANDRASEKHAR AND G. MÜNCH. *Astrophys. J.*, **115**, 103–23 (*Jan.*, 1952).

A new picture of the distribution of the interstellar matter is proposed which may be considered as an alternative to (or a refinement of) the current picture, which visualizes the interstellar medium as consisting of a distribution of discrete clouds. On this new picture the distribution of density is considered to be continuous but exhibiting fluctuations of a statistical character. The various problems of stellar statistics, such as the fluctuations in the counts of extragalactic nebulae and in the brightness of the Milky Way, are rediscussed in terms of this new picture, and it is shown that the observations can be interpreted equally in terms of it. However, the particular advantage of the continuous picture over the discrete picture is that the angular correlations in the brightness of the Milky Way in two neighbouring directions can be discussed without any additional assumptions. This latter problem is discussed in some detail, and it is shown that, by combining the results of the fluctuations in the brightness itself with the results of the angular correlations, it is possible to infer that the root mean square of the deviations in the density is about three to four times the mean density itself. A.

523.854.3

3236. Remark on the rotation problem of spiral systems. W. BECKER. *Z. Astrophys.*, **29**, 269–73 (*No.* 3, 1951) *In German.*

It is concluded that the sense of rotation of the Galaxy is such that the convex edges of its spiral arms are leading. D. R. BARBER

523.854.3

3237. Kinematics and dynamics of the galactic system. W. FRICKE. *Naturwissenschaften*, **38**, 438–48 (*No.* 19, 1951) *In German.*

After a review of interpretations of observed stellar motions, the ellipsoidal theory is criticized as inconsistent with the finite mass of the Galaxy. A programme of investigation is outlined for an isolated stationary system possessing axial symmetry; the velocity distribution function is regarded as a function of energy (kinetic + potential), and of angular momentum about the galactic centre, whose general form is determined by use of Poisson's equation. The investigation will apply to stars moving rapidly relative to the sun. Slowly moving stars and star clouds would involve perturbations in the general stellar field. R. A. NEWING

523.87

3238. An infrared system of bands of VO in *M*-type stars. P. C. KEENAN AND L. W. SCHROEDER. *Astrophys. J.*, **115**, 82–8 (*Jan.*, 1952).

Several groups of strong bands in the λλ7400–8600 region of late *M*-type stars are identified as members of a new infrared system of the VO molecule. Measurements on laboratory arc spectra allow a provisional vibrational analysis of the infrared system

into sets of eight main components. Like the well-known yellow bands (system *A*), the bands of the new system originate from the ground level of the molecule. The infrared VO bands appear to be present in all *M*-type stars of type *M*7 or later and become very strong in the coolest long-period variables. As the temperature decreases, they increase in strength relative to the adjacent TiO bands. A.

523.87 : 523.77

3239. Transition probabilities of forbidden lines. D. E. OSTERBROCK. *Astrophys. J.*, **114,** 469–72 (*Nov.*, 1951).

Transition probabilities are given for a number of forbidden lines of astrophysical interest. Also, from the computed transition probabilities, expected equivalent widths of [Ca II] and [S I] forbidden absorption lines in the solar spectrum are calculated. A.

523.872

3240. Continuous emission from planetary nebulae. L. SPITZER, JR AND J. L. GREENSTEIN. *Astrophys. J.*, **114,** 407–20 (*Nov.*, 1951).

Simultaneous emission of two photons by an H atom in the metastable 2*s* level is considered as a source of a continuum in planetary nebulae. Detailed calculations show that the probability of two-photon emission is $8{\cdot}23\ \text{sec}^{-1}$ and that the intensity of radiation emitted by this process increases markedly with increasing frequency. About 32% of electron captures lead directly to the 2*s* level and then to two-photon emission, since collisional de-excitation proves unimportant. Transitions from the 2*p* to the 2*s* level, induced by collisions with free electrons, convert a part of the remaining $L\alpha$ quanta into this continuous radiation, conversion occurring after a quantum of $L\alpha$ radiation has been scattered about 10^{10} times, on the average, in a region of ionized H. A neutral hydrogen region may surround the H II region. In such an H I envelope, about 10^{13} scatterings are required for conversion, but the density of neutral H is so much greater that most conversion by collision probably takes place there. The fraction of $L\alpha$ so converted may vary over a wide range, depending on the physical conditions. The theory is used to predict the total emission from an ionized hydrogen gas. The Balmer jump is reduced, and the decrement of the continua shortward of the Paschen and Balmer limits is also reduced. A bluish continuum is to be expected in the region from λ6000 to λ3646. The analysis applied to the ultraviolet observations now available results in a reduction of electron temperatures by about 25%. The available wide-slit observations indicate the possibility that a bluish "visual continuum" may exist. A.

523.872

3241. The temperature of the Crab-nebula central star. K. WURM. *Naturwissenschaften,* **38,** 496–501 (*No.* 21, 1951) *In German.*

Emission-line data for the filamentary structure observed in the spectral region 3 700 to 6 700 Å yield a computed temp. $\geqslant 500\,000°$ for the central star. Nineteen line identifications are tabulated within the range mentioned above. D. R. BARBER

523.874

3242. The speed of rotation of stars. K.-H. BÖHM. *Z. Astrophys.*, **30,** 117–33 (*No.* 2, 1952) *In German.*

Frequency-distribution diagrams, based on equatorial rotation velocities, derived from line-profile analyses, are given for stars of spectral class Be, O, B, A and F. The results for 300 stars fall within $\pm$ 10% of the max. frequency value for the respective groups. D. R. BARBER

523.874

3243. Radial-velocity measures of γ Bootis. G. R. MICZAIKA. *Z. Astrophys.*, **30,** 134–6 (*No.* 2, 1952) *In German.*

From 50 spectrograms of γ Bootis for the period April–July, 1951, a mean velocity of $-32{\cdot}2 \pm 1{\cdot}1$ km/sec is derived. No periodic velocity fluctuations in phase with the observed light curve are found. D. R. BARBER

523.877

3244. On the scattering opacity in the envelope of Trumpler stars. K. SUDA. *Sci. Rep. Tôhoku Univ., I,* **35,** 124–30 (*No.* 2, 1951).

The total opacity is expressed as $\kappa + 1{\cdot}5\,\sigma$, where σ is the contribution from electron scattering. The radius at which $\kappa = \sigma$, and the value of κ/σ at the surface, are calculated for different hydrogen contents in the case of several models. Scattering is found to be important for the model of smallest mass. R. A. NEWING

523.877

3245. The nonradial oscillations of gaseous stars and the problem of Beta Canis Majoris. P. LEDOUX. *Astrophys. J.*, **114,** 373–84 (*Nov.*, 1951).

The general characteristics of the non-radial oscillations of a rotating star are summarized and compared with the observations of β Canis Majoris. It is shown that the existence of two periods very close to each other as well as a phase shift of a quarter-period between the broadening of the lines and the corresponding radial velocity can be accounted for if the oscillation corresponds to a spherical harmonic of degree 2 in a rotating star. However, for free oscillations, the sign of the phase shift is opposite to the one observed when the periods are in the correct ratio, and vice versa. Forced oscillations are briefly discussed, and, although they offer a possibility of removing this discrepancy, a quantitative analysis presents difficulties due to the proximity of the hypothetical companion. A.

523.877

3246. On the difference in chemical composition between high- and low-velocity stars. M. SCHWARZSCHILD, L. SPITZER, JR AND R. WILDT. *Astrophys. J.*, **114,** 398–406 (*Nov.*, 1951).

The spectroscopic peculiarities of high-velocity stars—strengthening of the CH bands and weakening of the CN bands and of the metal lines—can tentatively be explained by a general reduction in the abundance of the heavy elements and a somewhat lesser reduction in the abundance of the medium-heavy elements, relative to the abundances for low-velocity stars. As a working hypothesis, it is proposed that such a general difference in chemical com-

position between stars of populations I and II stems from the preferential accumulation of grains in the denser interstellar clouds from which the stars of population I might be formed. The astrophysical discussion indicates that the dissociation energy of the molecules N_2 and CO should be close to 9·5 eV; the considerably lower or higher values still advocated by some spectroscopists are not supported by the astronomical evidence. A.

523.877

3247. Radial oscillations of a gaseous star of polytropic index 1. L. D. CHATTERJI. *Proc. Nat. Inst. Sci. India*, **17**, 467–70 (*Nov.–Dec.*, 1951).

523.877

3248. A note on the theory of two-phase configuration. B. P. NIGAM AND M. SUBHAN. *Proc. Nat. Inst. Sci. India*, **17**, 471–4 (*Nov.–Dec.*, 1951).

Bondi's semi-graphical method of integration of equations of stellar structure [Abstr. 3731 (1949)] is applied to Milne's two-phase model of white-dwarf stars, and the results compared with those obtained earlier by Kothari. A.

523.877

3249. On the analysis of Be spectra. I. The frequency of the He I state under conditions which depart from thermal equilibrium. II. The emission of an expanded atmosphere of small thickness. P. WELLMANN. *Z. Astrophys.*, **30**, 71–95 (*No.* 2, 1952) *In German.*

The distribution of atoms among different energy levels is investigated for an atmospheric shell excited by dilute radiation from a central star. Calculations are made for several values of a dilution factor which measures departure from conditions of thermodynamic equilibrium. The intensities of emission and absorption lines are determined for various states of an optically thin atmosphere. R. A. NEWING

523.877

3250. On the analysis of Be spectra. III. The spectrum of γ Cassiopeiae. P. WELLMANN. *Z. Astrophys.*, **30**, 96–116 (*No.* 2, 1952) *In German.*

Observed emission intensities are discussed in relation to the author's theoretical investigations (see preceding abstract), and an estimate is made of physical conditions in the atmospheric shell.

R. A. NEWING

523.877

3251. A rapidly convergent iteration procedure for the solution of the problem of radiative equilibrium. A. UNSÖLD. Note in *Naturwissenschaften*, **38**, 525–6 (*No.* 22, 1951) *In German.*

The total radiation flux $F(\tau)$ at optical depth τ is calculated for an assumed approximation S to the radiation intensity. The deviation of $F(\tau)$ from constancy is used to obtain a second approximation to S. Calculations for a grey atmosphere illustrate the accuracy of the method. R. A. NEWING

525.35

3252. A new method of analysis of the movement of the pole at the surface of the earth. P. J. MELCHIOR. *Bull. Acad. Roy. Belge Cl. Sci.*, **37**, 900–7 (*No.* 10, 1951) *In French.*

Continuation of previous work [Abstr. 6008 (1951)]. The variation of amplitude of the Chandlerian compt. of the polar motion is deduced from new values of the periodicity, based on material covering the epoch, 1900–50. Abnormal motion is found in the interval, 1935–40. D. R. BARBER

526.3

3253. On the basic principles of geodesy. F. A. VENING MEINESZ. *Bull. Géod., No.* 21, 299–306 (*Sept.*, 1951).

Proposes the projection of trigonometrical stations on to the geoid along true verticals instead of on to an ellipsoid along ellipsoid normals. This has the advantage that geodetic instruments are set up with reference to the true vertical and that heights above the geoid are directly determined by spirit levelling. To calculate co-ordinates there must be a further projection on to a reference ellipsoid but this is relatively simple if the form of the geoid is known; since the departures of the geoid from the best fitting ellipsoid are relatively small, no great error will be committed by assuming the geoid to be such an ellipsoid if its form is not known locally. A. H. COOK

526.59

3254. Datum adjustment with special consideration of Laplace and length conditions. H. WOLF. *Bull. Géod., No.* 21, 307–29 (*Sept.*, 1951).

This is performed to connect two or more independent trigonometric nets which have common points. The co-ordinates of the points of one set are expressed as polynomial functions of those of the other and the coefficients of the polynomials are determined from the co-ordinates of the common points by least squares. Criteria are given for the highest degree of polynomial to be used. The inclusion of independent data concerning deflections of the vertical at the origins of each set and of the results of base measurements and Laplace point observations is discussed. The problem is also stated in geographical co-ordinates. The connection of the Mecklenberg to the Prussian net is given as a numerical example. A. H. COOK

529.78

3255. Note on the frequency multiplication of a 1 c/s pendulum to 1 000 c/s. P. PARCELIER. *C.R. Acad. Sci.* [*Paris*] **234**, 190–1 (*Jan.* 7, 1952) *In French.*

A free-running tuning fork is synchronized by the impulses, and a second fork in a stable self-oscillating circuit is maintained at a harmonic frequency by means of a discriminator circuit. The system is used at Bordeaux Observatory. L. ESSEN

529.786 : 621.396.615

3256. Note on the effect of noise on the frequency of a valve oscillator. The ultimate precision of electronic clocks. A. BLAQUIÈRE. *C.R. Acad. Sci.* [*Paris*] **234**, 419–21 (*Jan.* 21, 1952) *In French.*

It is shown that the effect of valve noise on the frequency of a quartz-controlled oscillator is negligible compared with that of the resistance of the quartz element. An expression developed for the time or integrated frequency error due to this latter noise

gives a value of $1 \cdot 43 \times 10^{-7}$ sec in a sidereal day for a typical 50 kc/s quartz element in a Pierce circuit.

L. ESSEN

529.786 : 621.396.615

3257. Note on the effect of noise on the amplitude of a valve oscillator. A. LAQUIÈRE. *C.R. Acad. Sci. [Paris]* **234,** 710–12 (*Feb.* 11, 1952) *In French.*

A continuation of a previous note [preceding abstract]. The theory is extended to take the second-order terms into account and quantitative results are given for a particular case. L. ESSEN (R)

PHYSICS 53

53

3258. Experimental outcomes of laboratory instruction in elementary college physics. H. KRUGLAK. *Amer. J. Phys.*, **20,** 136–41 (*March*, 1952).

The purpose of the investigation was to compare the learning outcomes of the conventional and the demonstration methods in the general physics laboratory. The achievement criteria were two pencil-paper tests on mechanics theory and laboratory and two laboratory-performance examinations. The analysis of variance and covariance techniques were used to study the effects of the methods, the instructor, and the interactions between methods and instructors. The conventional method appeared to be more effective in teaching the simple manipulatory techniques, the understanding of instrumental set-ups, and the skill in solving simple problems using apparatus and materials of the elementary laboratory. A.

53.081 : 621.3.081

3259. The combination of the rationalized and unrationalized MKSA systems into a unified system. E. PERUCCA. *Ric. Sci.*, **21,** 1931–41 (*Nov.*, 1951) *In French.*

Taking as fundamental the expressions for the Coulomb force between electric charges and between magnetic poles, together with the electromagnetic force equation and the relation between current and charge, it is found that if rationalized values of μ_0, ε_0, and magnetic pole strength are defined as well, a system of units is obtainable, which contains all physical quantities in both rationalized and unrationalized forms. G. D. SIMS (R)

53.087.6 : 621.317.79

3260. An instrument to measure and compute the mean and standard deviation of the oscillations of a recording arm. B. HOGLEY. *J. Sci. Instrum.*, **29,** 76–81 (*March*, 1952).

An instrument is described which measures the displacement y of the arm of a pen recorder at regular intervals along the recording chart, whilst the chart is being produced. The instrument computes Σy and Σy^2. Its computing section does not contain a squaring device, but produces the square of a given measurement by means of an interconnected system of Post Office relays. The quantities Σy, Σy^2, and n, the number of measurements made, are displayed on Post Office type message registers. The quantities recorded facilitate the calculation of the mean and standard deviation of the pen arm displacement. A.

FUNDAMENTALS 530.1

530.1 : 525.24 : 538.1

3261. A fundamental theory of the magnetism of massive rotating bodies. G. LUCHAK. *Canad. J. Phys.*, **29,** 470–9 (*Nov.*, 1951).

A phenomenological theory, based on a relativistically covariant generalization of Maxwell's equations to include gravitational fields, is developed to account for the magnetic fields of massive rotating bodies. The equations yield the Wilson–Blackett expression for the magnetic moment of the earth and stars but give no magnetic field for mass-bodies moving without rotation in their own gravitational fields. They indicate that the magnetic field due to the motion of the earth in its orbit is negligibly small compared to the field due to its rotational motion, and they provide a possible explanation for the variable magnetic fields of light-variable stars. A.

530.112

3262. Is there an æther? H. BONDI AND T. GOLD; P. A. M. DIRAC. Letter in *Nature* [*Lond.*] **169,** 146 (*Jan.* 26, 1952).

The relationship of preferred motions (æther velocities) in Bondi and Gold's cosmological theory and Dirac's electrodynamics is discussed [see Abstr. 748 (1952)]. R. A. NEWING

530.112

3263. Dirac's new electrodynamics. K. J. LE COUTEUR. Letter in *Nature* [*Lond.*] **169,** 146–7 (*Jan.* 26, 1952).

See Abstr. 748 (1952) and preceding abstract. The energy-momentum tensor is considered and the æther velocity field is calculated for an electrostatic Coulomb field and for a plane electromagnetic wave.

R. A. NEWING

530.12

3264. On some static solutions of Einstein's gravitational field equations in a spherically symmetric case. H. NARIAI. *Sci. Rep. Tôhoku Univ., I,* **34,** 160–7 (*No.* 3, 1950).

Solutions are obtained for a line element of isotropic form. One solution is

$$ds^2 = \frac{1}{\Lambda}\left[a^2 \sin^2(\alpha + \log r)dt^2 - \frac{1}{r^2}d\sigma^2\right]$$

where a and α are constants and $d\sigma^2$ is the Euclidean metric for 3-space. Other solutions reduce to known results and others appear to be physically inadmissible.

R. A. NEWING

530.12

3265. On a new cosmological solution of Einstein's field equations of gravitation. H. NARIAI. *Sci. Rep. Tôhoku Univ., I*, **35**, 62–7 (*No.* 1, 1951).

The physical significance of a solution previously obtained (see preceding abstract) is discussed. The solution is found to correspond to an empty space with properties similar to those of a de Sitter universe.

R. A. NEWING

530.12

3266. Special theories of relativity. N. ROSEN. *Amer. J. Phys.*, **20**, 161–4 (*March*, 1951).

For a homogeneous isotropic medium in which some phenomenon takes place with which is associated a limiting speed c' and which is described by field equations which can be made covariant under linear space-time transformations, it is possible to set up a c'-relativity theory analogous to the Einstein (c-relativity) theory, but with the speed c' replacing c, the speed of light in empty space. Such a c'-relativity will have a limited domain of validity, but within this domain it can be useful in providing a conceptual framework for the description of phenomena. For different phenomena in different media one can have many different theories of relativity, among which the Einstein theory occupies a distinguished position. Examples of c'-relativity are mentioned, and the one appropriate to the Maxwell equations for a homogeneous isotropic dielectric is discussed. A.

530.12

3267. Quantization of Einstein's gravitational field: linear approximation. S. N. GUPTA. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 161–9 (*March*, 1952).

The approximate linear form of Einstein's gravitational field is quantized by using an indefinite metric. It is shown that only two types of gravitons can be observed, though many more can exist in virtual states in the presence of interaction. The observable gravitons are shown to be particles of spin 2. Using the interaction representation, the interaction of the gravitational field with the matter field is briefly discussed. A.

530.12

3268. The equations of motion and coordinate condition in general relativity. J. H. HAYWOOD. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 170–5 (*March*, 1952).

A new co-ordinate condition has been considered and the equations of motion of two bodies in their weak and quasistatic gravitational field have been derived to the second approximation. A number of additional second-order terms appear in the new equations which, however, have no influence on either the secular motion of the centre of mass or the rotation of periastron of the two-body system. A.

530.12

3269. The relativistic dynamics of a system of particles interacting at a distance. L. H. THOMAS. *Phys. Rev.*, **85**, 868–72 (*March* 1, 1952).

The dynamics of a system of particles acting on one another at a distance can be relativistically invariant if the assumption of invariant world-lines is given up. This is shown by constructing a particular dynamics in which invariance over the homogeneous Lorentz group is trivial, but space as well as time displacement requires the solution of equations of motion or of a Schroedinger equation. This particular dynamics reduces in the non-relativistic limit to the most general dynamics of a system of interacting particles admitting the Newtonian group. A.

530.145

3270. Non-linear geometric mechanics and the corresponding wave mechanics. B. KWAL. *C.R. Acad. Sci.* [*Paris*] **234**, 508–10 (*Jan.* 28, 1952) *In French.*

Discussion of a non-linear mechanics of point particles whose energy and momentum cannot exceed E_c and $\sqrt{(mE_c)}$. A corresponding wave mechanics with a critical wavelength λ_c is outlined, in which wavelengths $< \lambda_c$ correspond to unstable states of the particles. Displacements of atomic levels are discussed. R. H. DALITZ

530.145

3271. Point transformations in quantum mechanics. B. S. DEWITT. *Phys. Rev.*, **85**, 653–61 (*Feb.* 15, 1952).

An isomorphism is shown to exist between the group of point transformations in classical mechanics and a certain subgroup of the group of all unitary transformations in quantum mechanics. This isomorphism is used to indicate that the quantum analogues of physically significant classical expressions can be constructed uniquely in any co-ordinate system. There is no ambiguity in the ordering of non-commuting quantum operators, and the method of constructing the quantum analogues is covariant under general co-ordinate transformations. The method is actually only applicable to systems having Lagrangians which are at most quadratic in the velocities, but this includes all systems which are presently of interest in physics. The method is applied to two intrinsically non-linear examples, one of which is the gravitational field. The correct Hamiltonian operator for a quantized version of Einstein's gravitational theory is constructed. A.

530.145

3272. On the energy-momentum tensor in the theory of subtractive fields. L. DE BROGLIE. *C.R. Acad. Sci.* [*Paris*] **234**, 20–2 (*Jan.* 2, 1952) *In French.*

See Abstr. 5102 (1951).

530.145

3273. On the classical theory of the point charge. B. JOUVET. *C.R. Acad. Sci.* [*Paris*] **234**, 712–14 (*Feb.* 11, 1952) *In French.*

An eight-dimensional representation is given of the behaviour of the classical electromagnetic theory of a point electron under Lorentz and gauge transformations. R. H. DALITZ

530.145

3274. The quantization of the classical theory of spinning particles. S. SHANMUGADHASAN. *Canad. J. Phys.*, **29**, 593–612 (*Nov.*, 1951).

The classical theory of particles, possessing charge and dipole moment, and moving in an electromagnetic field, is considered on the assumptions that there is no constraint connection between the rota-

tional variables and the velocity of the particle, and that the two invariant squares of the dipole moment six-vector are constants of the motion. Two different schemes are obtained according as the two invariant scalar products of the dipole moment and total spin angular momentum six-vectors are or are not constants of the motion. The Bhabha–Corben theory fits into the former scheme. The classical schemes are put into canonical form by using for each particle the relativistic connection between the momenta and the rest-mass, modified to include the effect of the kinetic and potential energies due to spin and dipole moment, as the Hamilton–Jacobi equation and the usual Poisson brackets for the translational and total spin variables. The Wentzel field and the λ-limiting process are used mainly in dealing with the field. The variational principle for the Bhabha–Corben equations is given with the field treated according to the limiting process of Dirac or the relativistic cut-off method of Feynman. The quantization is completed by using the analogy rules. The changes required when the interacting field is a vector meson field are discussed. A.

530.145

3275. On the electrodynamics of the polarizable vacuum. E. BAGGE. Note in *Naturwissenschaften*, **38**, 566–7 (*No.* 24, 1951) *In German.*

A Lorentz-invariant formulation of an electrodynamic theory of a polarizable vacuum, extending the physical ideas of the author's earlier static theory [Abstr. 1441 (1952)]. In this new theory, a static charge has an everywhere finite field, which differs from that given by the earlier static theory.

R. H. DALITZ

530.145

3276. On the quantization of Dirac's new classical theory. I–II. J. G. VALATIN. *C.R. Acad. Sci.* [*Paris*] **234**, 64–7 (*Jan.* 2); 188–90 (*Jan.* 7, 1952) *In French.*

See Abstr. 981 (1952). The construction of the Hamiltonian formalism and the singularities of the equations are discussed. J. R. MADDOX

530.145

3277. Nonlinearities resulting from vacuum polarization in meson-nucleon interactions. B. J. MALENKA. Letter in *Phys. Rev.*, **85**, 686 (*Feb.* 15, 1952).

For a prescribed slowly-varying pseudoscalar meson field, the vacuum polarization effects are calculated completely, following Schwinger's proper-time method [Abstr. 5082 (1951)] and the most significant terms of the equivalent Lagrangian are shown to be the ϕ^2 (self-energy) and the ϕ^4 divergences. R. H. DALITZ

530.145

3278. Conservation laws in Feynman's modified electrodynamics. P. N. DAYKIN. *Canad. J. Phys.*, **29**, 459–62 (*Nov.*, 1951).

In Feynman's treatment of the self-energy problem, the divergence is eliminated by introducing a convergence factor into the integral over the virtual photon momentum space. Feynman has remarked that his choice of convergence factor is inconsistent with the conservation of energy for the radiation field of an atom. This problem is examined in a more general way. The modification of the Maxwell equations caused by the convergence factor is deduced. The modified field equations belong to the generalized electrodynamics described by Podolsky. The modified energy-momentum tensor is shown to satisfy the conservation law for the field with source. A.

530.145

3279. Divergence of perturbation theory in quantum electrodynamics. F. J. DYSON. *Phys. Rev.*, **85**, 631–2 (*Feb.* 15, 1952).

An argument is presented which leads tentatively to the conclusion that all the power-series expansions currently in use in quantum electrodynamics are divergent after the renormalization of mass and charge. The divergence in no way restricts the accuracy of practical calculations that can be made with the theory, but raises important questions of principle concerning the nature of the physical concepts upon which the theory is built. A.

530.145

3280. Electromagnetic properties of spin-one particles. D. LEENOV. *Phys. Rev.*, **85**, 841–9 (*March* 1, 1952).

An analysis of the electromagnetic properties of a charged particle with spin 1 is made from two standpoints. Part I contains a phenomenological treatment, in which the methods of field theory are used to investigate scattering processes involving a particle with spin 1 and magnetic moment $1 - \gamma$ magnetons, where γ is arbitrary. A calculation of the scattering cross-section for unpolarized particles is obtained, differing from the result of Laporte through the presence of the terms containing γ. Using this formula for the cross-section it is shown that studies of the multiple scattering of high-energy particles of this type will give a small but perhaps measurable indication of their spin and magnetic moment. Also, this theory shows that low-energy vector particles are not significantly depolarized when passing through matter, considering only electromagnetic effects. The μ-pair theory has been used by Wentzel as a description of the π-meson in order to predict certain of its properties. In Part II this theory is generalized to the case of a vector particle made up of a spinor pair, and descriptions are given of the computation of the magnetic dipole moment and the electric quadrupole moment, as well as the cross-sections for scattering and for dissociation because of interaction with a Coulomb field, here including the case of a pseudoscalar π-meson. These results, it must be noted, cannot be considered quantitative, owing to the cut-off method used; however, they may give useful qualitative information. A.

530.145

3281. A differential equation for the phase shifts in scattering problems. P. O. OLSSON. *Ark. Fys.*, **4**, 217–21 (*Paper* 9, 1951).

For a central potential a first-order differential equation is obtained [see also Bergmann, Abstr. 86 (1951)] whose solution approaches the scattering phase δ_l as $r \to \infty$. This equation is integrated numerically for several cases of interest.

R. H. DALITZ

530.145

3282. On the creation of pairs of particles in the processes of collision between particles of spin $\hbar/2$. J. PETIAU. *J. Phys. Radium*, **12**, 911–19 (*Dec.*, 1951) *In French.*

The differential cross-section is calculated for the creation of a pair of spin-$\frac{1}{2}$ particles E in the collision of spin-$\frac{1}{2}$ particles A and B, for the cases where all, two or none of A, B, E are identical and A, B, E interact through a scalar, pseudoscalar or vector field.

R. H. DALITZ

530.145

3283. On the calculation of the cross-section for emission of electromagnetic bremsstrahlung. G. PETIAU. *C.R. Acad. Sci.* [*Paris*] **233**, 1581–3 (*Dec.* 19, 1951) *In French.*

Completes an earlier calculation [Abstr. 3325 (1951)] of the bremsstrahlung cross-section in collision of relativistic spin-$\frac{1}{2}$ particles, by summing over the polarization states of the emitted photon.

R. H. DALITZ

530.145

3284. On the degree of polarization of the bremsstrahlung from thin anticathodes. O. BLUNCK AND K. DOFFIN. *Naturwissenschaften*, **39**, 38–9 (*No.* 2, 1952) *In German.*

From Sauter's relativistic theory (1934) of bremsstrahlung in electron collisions with light atoms, an approximate result is obtained for the polarization of bremsstrahlung emitted from a thin anticathode. Experimental results at 34 and 70 keV are not in agreement with this result.

R. H. DALITZ

530.145

3285. On the interaction between electromagnetic waves in matter. R. LUCAS. *C.R. Acad. Sci.* [*Paris*] **234**, 191–3 (*Jan.* 7, 1952) *In French.*

The conditions under which two e.m. waves travelling in a material medium can interact are examined. Relations are found connecting the frequencies and directions of the incident and reflected waves.

R. H. DALITZ

530.145

3286. On a degeneracy theorem of Kramers. M. J. KLEIN. *Amer. J. Phys.*, **20**, 65–71 (*Feb.*, 1952).

There is a theorem due to Kramers which states that the energy states of systems with an odd number of electrons remain at least doubly degenerate in the presence of any purely electric fields. The physical significance of this theorem, its proof and a discussion of the relationship of the Kramers degeneracy and the Wigner time-reversal operation are considered. A proof is given of the theorem that the expectation value of the magnetic moment operator is zero for any non-degenerate state.

A.

530.145

3287. On the subtractive field and the electron radius. S. SLANSKY. *C.R. Acad. Sci.* [*Paris*] **234**, 502–4 (*Feb.* 4, 1952) *In French.*

For a particle with magnetic moment, the self-energy remains divergent after the introduction of the subtractive field previously successful for the electrostatic field. On this basis a radius $\sim \hbar/2mc$ is attributed to the electron.

R. H. DALITZ

530.145

3288. Spin-spin relaxation in a simple system. J. EISENSTEIN. *Phys. Rev.*, **85**, 603–6 (*Feb.* 15, 1952).

A system of two particles of spin $\frac{1}{2}$ coupled by their dipolar interaction and in an arbitrary magnetic field is considered. It is shown that exact expressions for the energy levels of the system can be obtained. The density matrix is calculated exactly for the cases where a magnetic field is suddenly applied, parallel or perpendicular, to the line joining the dipoles. It is used in the evaluation of the magnetic moment of the system. Instead of there being a gradual approach to an equilibrium situation the magnetic moment varies harmonically in time. A partially successful attempt is made to calculate the density matrix when the functional dependence of the magnetic field on the time is more complicated than a step function. The exact calculations for this simple system are compared with the approximate calculations of Waller for a system of N spins. It is pointed out that there may be no gradual approach to equilibrium in the N-spin system, either.

A.

530.145

3289. Multiple scattering of waves. II. The effective field in dense systems. M. LAX. *Phys. Rev.*, **85**, 621–9 (*Feb.* 15, 1952).

The multiple scattering of waves interacting with a system of particles is treated by a self-consistent approach. Scattering processes are described by operators that permit anisotropy, absorption and creation. The scattering system may be randomly, partially or completely ordered. The propagation constant k' of the coherent wave in the scatterer medium differs from the vacuum constant k by $(k')^2 = k^2 + 4\pi ncf(\mathbf{k}', \mathbf{k}')$, where n is the scatterer density and f is an operator whose matrix elements $f(\mathbf{b}, \mathbf{a})$ represent the scattering amplitude in direction $\mathbf{b}$ for a wave incident in direction $\mathbf{a}$ on a single scatterer bound by the forces of its neighbours. The parameter c, defined by $cf(\mathbf{k}', \mathbf{k}') = \int \exp(-i\mathbf{k}'.\mathbf{r}) f \times \psi_e(\mathbf{r}) d\mathbf{r}$, is a measure of the ratio of the effective field $\psi_e(\mathbf{r})$ to the average field. An integral equation is found for $\psi_e(\mathbf{r})$ with the help of a "quasi-crystalline" approximation. A variational expression is then found for c that becomes exact for point scatterers. A comparison is made of finite and infinite scattering systems. The extinction theorem is proven. The macroscopic viewpoint is found to be applicable to small systems whose size is large compared to the scatterer potential range, and the range of scatterer position correlations.

A.

530.145

3290. The hypothesis of charge independence for nuclear phenomena. K. M. WATSON. *Phys. Rev.*, **85**, 852–7 (*March* 1, 1952).

The hypothesis of charge independence for nuclear phenomena is a symmetry condition which leads to non-trivial relationships to be satisfied by an extensive class of meson-nucleon interactions. Application of the principle to meson production by nucleon collisions and by photons and to meson scattering leads to a number of sensitive tests of the hypothesis. No contradictions are found from the present rather limited experimental data. Extension of the principle

to heavy unstable particles (such as *V*-particles) is discussed. A.

530.145

3291. Relativistic theory of spin. YU. M. SHIROKOV. *Zh. Eksper. Teor. Fiz.*, **21**, 748–60 (*No.* 6, 1951) *In Russian.*

Relativistically invariant definitions of spin and centre of mass are investigated. A covariant division of spin and orbital momentum is introduced and the possibility of an invariant classification of the states of an arbitrary particle according to the proper values of the 4-momentum, the square of the spin and one of its components is demonstrated. The related theory of the relativistic mass centre is developed and affords a partial explanation of the "zitterbewegung" of a Dirac electron. A particle with non-discrete internal degrees of freedom is investigated, and it appears possible to ascribe to it a mass spectrum increasing with increasing spin. W. J. SWIATECKI

530.145

3292. Angular momentum in nonlocal field theory. D. R. YENNIE. *Phys. Rev.*, **85**, 877–80 (*March* 1, 1952).

The decomposition of arbitrary non-local fields into irreducible parts is discussed. It is shown that the spin of a non-local particle is made up of two parts arising, respectively, from the transformation properties and from the non-local nature of the field; the two parts combine vectorially to give the total spin. A.

530.145 : 537.12

3293. On the quantum theory for a finite-sized electron. I. G. J. YEVICK. *Phys. Rev.*, **85**, 911–17 (*March* 1, 1952).

Discusses briefly different types of models for a finite-sized electron from the classical point of view, each model being characterized by a particular type of charge-current distribution. Each of these models can be quantized by the Feynman Lagrangian procedure and the new problems encountered are analysed. These problems are illustrated by detailed calculations for the first-order perturbation calculation of a finite-sized electron interacting with an external field. A.

530.145

3294. Calculation of the square-well potential for the neutron-proton interaction from experiments. F. KATSCHER. *Acta Phys. Austriaca*, **5**, 89–122 (*No.* 1, 1951) *In German.*

The deuteron binding energy and *n–p* scattering cross-sections are used to calculate the depth and range of a square-well potential for the triplet and singlet state with $l = 0$ under the assumption of central forces. An infinity of solutions turns out to be compatible with the data, but the results of recent coherent *n–p* scattering experiments enable a choice to be made. The triplet range is then different from the singlet range, but the latter is near the *p–p* square-well range and the associated depths differ by only $\sim 4\%$ from the *p–p* values. The charge independence hypothesis is thus confirmed. W. J. SWIATECKI

530.145

3295. On the analysis of elastic scattering of nucleons due to the meson fields. C. MARTY. *J. Phys. Radium*, **12**, 833–40 (*Nov.*, 1951) *In French.*

The g^4 cross-sections for nucleon-nucleon scattering due to exchange of one meson are calculated for all meson fields, and the validity of such 2nd-order calculations is discussed. The results are compared with the high energy *n–p* and *p–p* data, which cannot be fitted with a simple meson field of π-meson mass, nor with any mixture of neutral scalar mesons of π-meson mass with charged fields. R. H. DALITZ

530.145

3296. Rational formulation of the theory of spin 1 particles in view of a theory of mesons and nuclear forces. B. KWAL. *J. Phys. Radium*, **12**, 868–72 (*Nov.*, 1951) *In French.*

By introducing "true potentials" suggested by rewriting the equations of spin 1 particles in a 5-dimensional form it is possible to obtain a formulation of the Maxwellian C_1^1, Broglian C_0^1, pseudo-Maxwellian $C_1'^1$ and pseudo-Broglian $C_0'^1$ particles with only r^{-1} singularities. W. J. SWIATECKI

530.145

3297. Calculation of *S*-matrix elements. J. S. R. CHISHOLM. *Proc. Camb. Phil. Soc.*, **48**, 300–15 (*Pt* 2, 1952).

All factors corresponding to lines in Feynman–Dyson graphs are put in the form of scalar boson line factors acted on by certain operators $\mathcal{F}$ and $\mathcal{V}_\alpha$ involving only the energy-momenta of external lines and particle masses. A general formula is given for the integral of a product of scalar boson factors, and the effect of a product of operators $\mathcal{F}$ and $\mathcal{V}_\alpha$ on this result is described. The infinities appear in a different form, and it is shown how subtraction procedure can be applied to eliminate them. A.

530.145

3298. What is the expression analogous to the Poynting vector for the field of scalar and pseudoscalar mesons? V. S. VRKLJAN. *C.R. Acad. Sci.* [*Paris*] **234**, 301–3 (*Jan.* 14, 1952) *In French.*

The analogue of the Poynting vector is shown to be $c\dot{\phi}$ grad ϕ in the neutral meson theories of spin zero, and $c\dot{\phi}[\text{grad} + (ie/\hbar c)A]\phi$ in Proca's charged pseudoscalar theory. R. H. DALITZ

530.145

3299. Mesonic proper-field. H. UMEZAWA, Y. TAKAHASHI AND S. KAMEFUCHI. *Phys. Rev.*, **85**, 505–16 (*Feb.* 15, 1952).

A method is presented of treating the meson cloud around the nucleon. The meson cloud is described in terms of the free field operators which coincide, on the world point on the space-like surface, with the usual field operators in the Heisenberg representation. The relation between the field and its source on an arbitrary space-like surface is studied. The method of the phenomenological investigation of the meson cloud in the authors' formalism and the treatment of the problem of the multiple production of mesons and the magnetic moment of the nucleon-meson system are discussed. This treatment of the multiple production of mesons is shown to be the covariant generalization of Bloch–Nordsiecks' method for the multiple production of low-energy photons. A.

530.145

3300. Meson tail effect and treatment of proton-proton scattering data. M. C. YOVITS, R. L. SMITH, JR, M. H. HULL, JR, J. BENGSTON AND G. BREIT. *Phys. Rev.*, **85**, 540–54 (*Feb.* 15, 1952).

The fit of experimental material on proton-proton

attering by phenomenological potentials is reviewed ith the inclusion of observations by Heydenburg–ittle in the 300 keV region and of Cork at 30 MeV. /eighting of data by a criterion based on internal onsistency is employed. Data obtained by means of an de Graaff machines are used to determine the est fits for different shapes of potential energy curves. ther data are compared with the resultant (f, E) plots aphically. A trend towards agreement with the ng-tailed Yukawa and exponential well potentials noticeable among the supposedly more accurate easurements of Rouvina and of Cork. The meson otential $-Ce^{-r/a}/(r/a)$ with $C = (93{\cdot}4 \pm 1{\cdot}0)mc^2$, $= (0{\cdot}412 \pm 0{\cdot}002)e^2/mc^2$ fits experiment and corre-onds to a meson mass of $333 \pm 2m$, the limits of ror being stated above somewhat arbitrarily. The fect of the tail of the Yukawa potential on scattering studied with particular attention to its influence on ie nearly linear functions of energy used in the nalysis of experiment, and on the coefficients of owers of the energy in the expansion of this function). The convergence of the power series is better if ne tail of the potential is chopped off. Calculation f coefficients in this series is also easier for the otential without tail. The more practical arrange-ents of calculations are: (*a*) direct calculation of f r a number of energies, the tail effect being treated y a first-order approximation; and (*b*) calculation of efficients of powers of E in the series for f for otential without tail followed by first-order calcula-on of effect of tail on f. Results obtained in these ays are compared. A.

530.145

301. The impulse approximation. G. F. CHEW ND G. C. WICK. *Phys. Rev.*, **83**, 636–42 (*Feb.* 15, 52).

An analysis is made of the assumption that the attering of an elementary particle by a complex ucleus is well approximated by the superposition of utgoing waves generated by the individual nucleons cting independently. The special case of nucleon-ucleon scattering is discussed in detail and an esti-ate given of the order of magnitude of the error in e approximation. Application of the method to eson problems is also discussed. A.

530.145

302. Comment on the "impulse approximation." ASHKIN AND G. C. WICK. Letter in *Phys. Rev.*, , 686 (*Feb.* 15, 1952).

An expansion used in Chew and Wick's discussion receding abstract) of the impulse approximation is re derived. R. H. DALITZ

530.145

303. On polarized particle beams. R. H. DALITZ. *oc. Phys. Soc.* [*Lond.*] *A*, **65**, 175–8 (*March*, 52).

A partially polarized beam of particles is repre-nted by a statistical operator in spin space. For ucleon-nucleon scattering a theorem stated by olfenstein in 1949 connecting the two simplest periments involving polarized nucleons is shown to pend on the invariance of the interaction potential der time-reflection. A.

530.145

3304. On the statistical distribution of the motion of particles in quantum mechanics. A. RÉGNIER, E. SCHATZMAN AND J.-P. VIGIER. *C.R. Acad. Sci.* [*Paris*] **234**, 410–12 (*Jan.* 21, 1952) *In French.*

The introduction of a real quantum field (a "guiding wave") in wave mechanics and simple considerations on the equipartition of energy between this field and the particles which it guides, lead to the statistical distribution of Schrödinger for the mean state. R. H. DALITZ

530.145

3305. Solution of perturbation equations. I. The amplitudes. M. FABRE DE LA RIPELLE. *C.R. Acad. Sci.* [*Paris*] **234**, 412–14 (*Jan.* 21, 1952) *In French.*

From the Fourier transform of the equations of the Dirac "variation of parameters" treatment of a time-independent perturbation, a non-linear recurrence relation is established for the successive calculation of the probability amplitudes. R. H. DALITZ

530.145

3306. Applications of conservation of parity in quantum mechanics. I. Disintegration into two or three bosons of non-zero mass. L. MICHEL. *C.R. Acad. Sci.* [*Paris*] **234**, 703–5 (*Feb.* 11, 1952) *In French.*

If scalar, vector, pseudovector and pseudoscalar boson be denoted by S, V, A, P respectively, the spontaneous disintegration of a boson into distinct bosons of non-zero masses is strictly forbidden if the initial and final bosons form one of the following groups—*SSP*, *PPP*, *SPV*, *SSA*, *PPA*, *SSSP*, *SPPP*—irrespective of which of the group is the initial boson. R. H. DALITZ

530.145.6

3307. On the possibility of an objective and causal interpretation of wave-mechanics. L. DE BROGLIE. *C.R. Acad. Sci.* [*Paris*] **234**, 265–8 (*Jan.* 14, 1952) *In French.*

The author decides that his theory of 1927, involving irregular solutions of the wave equation, cannot give a causal interpretation of wave-mechanics. J. R. MADDOX

530.145.6

3308. A note on the choice of physically useful solutions of the Schrödinger equation. G. FALK AND H. MARSCHALL. *Z. Phys.*, **131**, 269–72 (*No.* 2, 1952) *In German.*

It is shown that there exist solutions in the hydrogen-atom, spherical box and three-dimensional harmonic oscillator problems which have poles at the origin, while satisfying the boundary condition and being quadratically integrable. J. R. MADDOX

530.162

3309. Experimental verification of the theory of the Brownian movement with the aid of measurements of diffusion of a suspension of carbon black. J.-B. DONNET AND C. SADRON. *C.R. Acad. Sci.* [*Paris*] **234**, 69–71 (*Jan.* 2, 1952) *In French.*

Experiments on suspensions of carbon black give proof of the theory of the Brownian movement and also show the Stokes law to be true for spheres whose diameters are of the order of 200 Å. T. C. TOYE

530.162

3310. Collision probability for spherical molecules as a function of their thermal velocity. J.-J. BERNARD. *C.R. Acad. Sci.* [*Paris*] **234,** 510–12 (*Jan.* 28, 1952) *In French.*

This is obtained using the transformation derived in Abstr. 1483 (1952). R. H. DAVIES

530.162 : 519.21 : 621.391

3311. Information theory and inverse probability in telecommunication. P. M. WOODWARD AND I. L. DAVIES. *Proc. Instn Elect. Engrs, Pt III,* **99,** 37–44 (*March,* 1952)

The foundations of information theory are presented as an extension of the theory of inverse probability. By postulating that information is additive and taking suitable averages, all the essential definitions of Shannon's theory for discrete and continuous communication channels, with and without noise, are obtained. The theory is based on the idea that receiving a communication, or making an observation, merely changes the relative probabilities of the various possible messages. The whole process of reception can therefore be regarded as a means of evaluating *a posteriori* probabilities, and this leads to the idea that the optimum receiver in any telecommunication problem can always be specified, in principle, by inverse probability. The simplest instance is the correlation receiver for detecting very weak signals in the presence of noise, and its theory is briefly discussed. Possible criticisms of the use of inverse probability are answered. A.

530.162 : 536.753

Entropies of mixing in athermal mixtures of molecules of single and double size. *See Abstr.* 3559

530.162 : 537.3 : 621.3.018.78 : 621.395.645

3312. Study of certain statistical models relating to problems of background noise. A. BLANC-LAPIERRE. *Rev. Sci.* [*Paris*] **89,** 139–50 (*May–June,* 1951) *In French.*

The importance of amplifier distortion of background noise is emphasized. The forms of spectra to be expected from various combinations of sources and amplifiers are considered. N. L. JOHNSON

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.252 : 517.947

The relaxation method in stress analysis. *See Abstr.* 3203

531.252.3

3313. The stress distribution near a loading point in a uniform flanged beam. *Philos. Trans A,* **244,** 417–67 (*No.* 886, 1952).

531.259

3314. On the points in an elastic prism where rupture is promoted when it is subjected to increasing stress. F. TEISSIER DU CROS. *C.R. Acad. Sci.* [*Paris*] **234,** 47–9 (*Jan.* 2, 1952) *In French.*

The stability of a prism subjected to external forces is considered. J. E. CAFFYN

531.259

3315. The application of elasticity to the resistance of materials. H. PAILLOUX. *C.R. Acad. Sci.* [*Paris*] **234,** 49–51 (*Jan.* 2, 1952) *In French.*

Approximations for the displacements of points in a beam subjected to external stress are derived. J. E. CAFFYN

MECHANICAL MEASUREMENTS 531.7

531.715.15

3316. Apparatus for the control of straightness. A. MIRAU. *Rev. Opt. (Théor. Instrum.)* **30,** 357–65 (*Aug.–Sept.,* 1951) *In French.*

A long tube contains 7 pivoted, partially reflecting mirrors and an autocollimator. The deflections of the mirrors can be read simultaneously in the eyepiece. The apparatus is adjusted on a flat surface, and when placed upon the test piece the deflections give a measure of the profile. Constructional details are given and the accuracy (about 1 sec of arc) is compared with that of other methods of measuring straightness of flat tables, tubes, etc. The speed and ease of operation are features of this method. R. W. FISH

531.717 : 620.179.14 : 621.317.49

3317. A magnetic thickness gauge of new design. E. G. HARRISON. *J. Sci. Instrum.,* **29,** 89–91 (*March,* 1952).

The thickness of non-magnetic coatings on magnetic base metals is determined, as in other instruments, by the force of adhesion of a small magnetic element or armature to the surface. In existing designs this force is balanced by means of a gravitational couple, spring tension or electromagnetic pull. The instrument described employs a movable permanent magnet to produce the balancing force, but the same magnet also serves to energize the armature which is of soft iron, by induction. Movement of the permanent magnet towards the armature causes an increase in both the force of adhesion and the balancing force: the latter, however, increases more rapidly and there is a unique position at which the armature is released for any given coating thickness. The accuracy compares favourably with that given by other instruments. Modifications are described whereby the range may be extended in both directions. A.

531.764.5 : 621.317.39

3318. Accurate time for scientific observations. F. E. FOWLER. *Electronics,* **25,** 98–100 (*Jan.,* 1952).

The equipment described enables accurate operation of exactly synchronized interval timers, exposure meters and clocks at a number of outstations controlled from a master station. A frequency standard, a temp.-controlled quartz-crystal oscillator operating at 90·72 kc/s, provides a 60 c/s supply for driving the clocks with a stability of better than ±0·1 sec/24 hr. From time to time these clocks are checked against the time signals from WWV and a reliable means of

orrecting all clocks simultaneously is required. ccordingly the frequency-standard output is con-erted to 3-phase and then applied to the stator indings of a selsyn. The clock system is driven rom the rotor of this selsyn and every complete otation of it will apply a correction of 1/60 sec. The ime signals from WWV are filtered, amplified and nally made to provide a strong pulse which fires a trobotron lamp once per sec. This lamp illuminates stroboscopic disk driven at 1 rev/sec by the clock upply, so indicating the amount and sign of the error. H. G. M. SPRATT (R)

531.787, 533.4

319. Capillary depression in mercury barometers nd manometers. F. A. GOULD AND T. VICKERS. . *Sci. Instrum.*, **29**, 85–7 (*March*, 1952).

An account is given of the preparation of a new able of values of the capillary depression in tubes of Ig barometers and manometers. The table has an ntirely theoretical basis and has been computed by recise methods of interpolation from two existing ables in which the values, being expressed in terms f dimensionless quantities, are not in a form suitable or everyday use in pressure measurement. The chief eatures of the new table are that it covers a wide range f values of meniscus diameter and height, and also ives values of the capillary depression corresponding o three different values of the surface tension. xcept for the smallest tubes, these values are given o the nearest 0·001 mm. Both in scope and accuracy he table is considered to be a substantial improve-ient on previously published tables giving the apillary depression directly in terms of meniscus eight and diameter as arguments. A.

531.787.6 : 621.317.79

320. A diaphragm-type micromanometer. M. ORANT. *Electronic Engng*, **24**, 80–1 (*Feb.*, 1952).

A pressure-cell, with a thin corrugated diaphragm, s connected to the system containing the sample of as or vapour, the cell itself being enclosed in a cham-er which is either evacuated or filled to a reference ressure. Two concentric air coils are mounted above he non-magnetic metal diaphragm, their mutual nductance changing linearly with its displacement. 'ressures in the range 1–100 microns can be measured o an accuracy of ~0·2%. A. J. KENNEDY (R)

531.787.9

321. Calibration of a resistance wire pressure auge. P. JOHANNIN. Letter in *J. Phys. Radium*, **13**, 6 (*Jan.*, 1952) *In French.*

Some preliminary results concerning the use of the ow-resistance temperature coefficient manganin alloy minalpha" are reported. The gauge consisted of a 5 ohm coil and its resistance under pressure was ompared with a similar coil, at the same temperature nd at atmospheric pressure, by a potentiometric ethod to a precision of order of 3×10^{-6}. Up to 000 kg cm^{-2} the resistance varied linearly with ressure. The resistance pressure coefficient was ·305 ± 0·003 kg^{-1} cm^2 and was the same at 20, 25 nd 30°C. Hysteresis, after reaching the highest ressure, was less than 5 kg cm^{-2}. S. WEINTROUB

MECHANICS OF FLUIDS 532

532.1

3322. The principle of the conservation of energy, according to Lagrange, for liquids at rest. G. MANERA. *Atti. Accad. Sci. Torino I*, **85**, 348–54 (1950–51) *In Italian.*

Mathematical. Starting from the equation ρ grad ϕ = grad p for a liquid, pressure p and density ρ, subjected to the action of a field of force of potential ϕ and applying an infinitesimal force, the elastic portion of the energy of the liquid is shown to be due to the compressibility. S. WEINTROUB

532.13

3323. The intrinsic viscosity of low molecular weight polystyrenes. D. C. PEPPER. *Sci. Proc. Roy. Dublin Soc.*, **25**, 239–50 (*Nov.* 15, 1951).

In order to investigate whether the Mark–Houwink relation $\eta = KM^{\alpha}$ holds for short chains, polystyrenes of 10^3–10^4 mol. wt. were examined. Both for fractionated and unfractionated polymers K and α remain constant, being given by $\eta = 2{\cdot}7\times10^{-4}\,M^{0{\cdot}66}$, $\eta = 4{\cdot}37\times10^{-4}\,M^{0{\cdot}66}$ resp. J. JACOBS

532.13 : 532.77

3324. On the frequency dependence of the viscosity of high polymer solutions. R. CERF. *J. Chem. Phys.*, **20**, 395–402 (*March*, 1952).

The ultrasonic shear waves technique introduced by Mason offers the possibility of measuring the viscosity of a liquid in laminar flow at ultrasonic frequencies. A dilute high polymer solution exhibits, besides the usual shear viscosity, a shear elasticity as well for rather low frequencies (of the order of 10^5). A theory is given for infinitely dilute solutions using as a model for the chain molecule an elastic sphere. This model, which the author has used previously for the theory of flow birefringence, represents the limiting case of complete impermeability. The theory is compared with experimental results of Baker, Mason and Heiss and of Rouse on polystyrene. The theory gives a good picture of the phenomena as a whole and is particularly successful in describing the apparently anomalous temperature dependence of the elasticity coefficient of polystyrene solutions at high frequencies. The interest of combining results on flow birefringence and on high-frequency viscosity measurements is emphasized, as well as the possibilities of the latter technique for determining the molecular elasticity and internal viscosity as a function of frequency. On the basis of preliminary results for a sample of polystyrene of molecular weight 130 000, the tentative conclusion is given that the elastic sphere model will not have a quantitative significance for chains of such a low molecular weight and that it might be necessary to take into account the effect of permeation. A.

532.13 : 535.515

3325. Making visible viscosity waves in liquids. A. CARRELLI AND G. BRANCA. Letter in *Nuovo Cim.*, **8**, 889–90 (*Nov.*, 1951) *In Italian.*

The waves formed in a colloidal Fe solution by the action of an oscillating crystal cause the liquid to become doubly refracting. The waves can then be

detected by the use of polarized light and a Babinet compensator. Three photographs are shown.
R. W. FISH

532.133

3326. A note on the extension of Poiseuille's equation to non-Newtonian liquids. A. KATCHALSKY AND N. STERNBERG. *Bull. Res. Coun. Israel*, **1**, 111–13 (*Aug.*, 1951).

A consideration of the theory underlying the measurement of viscosity of non-Newtonian liquids in capillary tube viscometers. T. C. TOYE

532.137

3327. Exact formulas for the plate and cone viscometer. T. BRAUN. Letter in *Bull. Res. Coun. Israel*, **1**, 127 (*March*, 1951).

532.137

3328. A simple arrangement for a rotating cylinder viscometer. F. H. HIBBERD. *Amer. J. Phys.*, **20**, 134–5 (*March*, 1952).

A modification of the rotating-cylinder method of measuring coefficients of viscosities of liquids, suitable for advanced laboratory classes, is described. The terminal angular velocity is measured for a series of driving torques and of depths of liquid. End effects can be eliminated by appropriate treatment of the data. A.

532.51

3329. Derivation of model characteristics for typical flow systems and their technical applications. E. SCHWARZ-BERGKAMPF. *Acta. Phys. Austriaca*, **5**, 123–8 (*No.* 1, 1951) *In German.*

The description of flow systems in terms of Reynolds, Nusselt and Prandtl numbers is briefly discussed and applications are indicated. E. H. DOCK

532.51

3330. On the dynamics of perfect fluids and Hamilton's principle. J. DELVAL. *Bull. Acad. Roy. Belge Cl. Sci.*, **37**, 986–90 (*No.* 11, 1951) *In French.*

532.51

3331. An expansion formula for the drag on a circular cylinder moving through a viscous fluid at small Reynolds numbers. S. TOMOTIKA AND T. AOI. *Quart. J. Mech. Appl. Math.*, **4**, 401–6 (*Dec.*, 1951).

The formula is derived from the general expression for the drag on the cylinder. It is expressed as a power series in the Reynolds number. The formula, correct to the 4th power of this number, can be used with sufficient accuracy provided the number is numerically less than 4. L. S. GODDARD

532.51

3332. Unsteady flows with free boundaries. D. GILBARG. *Z. angew. Math. Phys.*, **3**, 34–42 (*No.* 1, 1952).

Unsteady flows, within a finite space, past polygonal obstacles are discussed mathematically by making the assumption that the free boundaries are stream lines. The mathematical treatment follows the customary procedure along conformal representation lines, and presents essentially no more difficulties than does the classical problem of free boundaries in the case of steady flows. Symmetrical flow past a plane is discussed, and explicit formulae for flows within cavities of constant shape are derived. J. S. G. THOMAS

532.51

3333. The tracing of the tracks of particles in a moving liquid. J. MARVAUD. *C.R. Acad. Sci. [Paris]* **234**, 401–3 (*Jan.* 21, 1952) *In French.*

It is assumed that the liquid velocity is large enough for gravity effects to be neglected, that its density is $\ll$ that of the particles, and that the tracks are plane. The vector equation can be solved by electrolytic tank methods, and the required graph traced by a device described elsewhere [Abstr. 3577 (1952)] in which a current line is established as the analogue of the particle track. The method has been successfully applied to the problem of the motion of water droplets in an air stream. A. J. KENNEDY

532.513.1

3334. Pressure energy and Bernoulli's principle. G. A. LINDSAY. *Amer. J. Phys.*, **20**, 86–8 (*Feb.*, 1952).

An effort is made to show that the concept of pressure in an incompressible fluid as energy per unit volume possessed by the fluid is an erroneous one, and that Bernoulli's equation is not to be interpreted as a statement of conservation of energy, but rather as a relation between pressure, velocity and height in the gravitational field. A.

532.516

3335. Studies in Newtonian flow. III. The dependence of the viscosity of liquids on molecular weight and free-space (in homologous series). A. K. DOOLITTLE. *J. Appl. Phys.*, **23**, 236–9 (*Feb.*, 1952).

For Pt II, see Abstr. 1504 (1952). The free-space concept, previously applied to variation resulting from a change in temperature only, is here adapted to a case where both temperature and molecular weight vary. The molecular weight range of the *n*-paraffins illustrative of this case is limited to $m = 100$ through $m = 240$. Over this range of molecular weights the family of lines represented by $\ln\eta = B(v_0/v_f) + \ln A$ intersects the vertical axis at very nearly a common point. By assuming a common intercept and representing the slopes of this family of lines in terms of molecular weight, an expression defining viscosity as a function of molecular weight and free-space is deduced. This expression reproduces the "selected data" satisfactorily over the molecular weight range mentioned. Its greater significance as a step in the development of a far more useful function will become apparent in the succeeding paper. A.

532.517.4

3336. Some remarks on the dynamical and thermal structure of a heated turbulent fluid. E. INOUE. *J. Phys. Soc. Japan*, **6**, 392–6 (*Sept.–Oct.*, 1951).

Spectral functions for the velocity and temperature fluctuations in heated turbulent flow are obtained in the forms: $F(k)\sim\varepsilon^{2/3}k^{-5/3}$, $G(k)\sim(K/K_H)^2Q^2\varepsilon^{-2/3}k^{-7/3}$ for the intermediate scale of turbulence element (turbulon) and $F(k)\sim(\varepsilon/\nu)k^{-3}$, $G(k)\sim Q^2\kappa^2k^{-5}$ for the smallest scale. Here k is the turbulon wave number, ε the rate of energy dissipation, Q that of heat transfer, ν the kinematic viscosity, κ the heat diffusivity, K the turbulent viscosity and K_H the turbulent heat diffusivity. Then the concept of smallest turbulon is

defined as the intersection of two forms of the spectral function. Thus it turns out that the scale of smallest dynamical turbulon coincides with that of smallest thermal turbulon provided the Prandtl number ν/κ is equal to K/K_H. A.

532.517.4

3337. Turbulent motion. G. K. BATCHELOR. *Rep. Phys. Soc. Progr. Phys.*, **15**, 101–41 (1952).

Most of the advances in this subject have occurred since about 1935 and are still being pursued actively, since turbulent motion is not yet understood properly. The emphasis is on the physical content of the various ideas and results rather than on their mathematical formulation. A prominent place is given to the universal similarity theory since this seems likely to provide a valid (although partial) description of the small-scale components of the motion. A section is devoted to a problem which occurs in many different physical fields, viz. the effect of turbulent convection on the distribution of various local properties of the fluid. The recent work on the study of homogeneous decaying turbulence is summarized. The very important and extensive problem of turbulent shear-flow is considered, although it has not been possible to do justice to all the available experimental results. There is an appendix on the advances in measuring technique that have made possible much of the recent research. Bibl. 74 refs. A.

532.517.4

3338. The spectra of turbulence in a compressible fluid; eddy turbulence and random noise. J. E. MOYAL. *Proc. Camb. Phil. Soc.*, **48**, 329–44 (*Pt* 2, 1952).

The state of a real fluid is completely specified by its velocity, density, pressure and temperature fields. When the fluid is in turbulent flow, all these quantities fluctuate in a disordered manner. The method of space Fourier spectra is used to show that these field variables separate into two physically distinct groups, one corresponding to fluctuating acoustical waves, or random noise, and the other to fluctuating vorticity, or eddy turbulence. The corresponding decomposition of the spectral and correlation tensors in a homogeneous field of turbulence is given. The noise Fourier components are shown to be coupled to the eddy Fourier components only through the non-linear inertia terms in the dynamical equations of the fluid; whereas the former propagate as acoustical waves, the wave character of the latter is due entirely to the mean motion of the fluid. The measurement of the noise component, its attenuation through absorption by walls and its effects on the eddy component are discussed. Finally, the dynamical equations for the eddy component of the velocity spectral tensor in a homogeneous field of turbulence are compared with the corresponding equations for an incompressible fluid. A.

532.52

3339. Statistical theory of non-homogeneous turbulence. J. ROTTA. *Z. Phys.*, **131**, 51–77 (*No.* 1, 1951) *In German.*

The theory of Pt I [Abstr. 7590 (1951)] is extended to cover variation in space and time, and the results are expressed in terms of a length characteristic of the turbulence. Results obtained with a wind tunnel are compared and it is concluded that the mechanism of turbulence can be explained qualitatively. E. H. DOCK

532.52

3340. An improved method for the measurement of the velocity profiles in liquids. J. E. CAFFYN AND R. M. UNDERWOOD. Letter in *Nature* [*Lond.*] **169**, 239–40 (*Feb.* 9, 1952).

Oil drops are photographed with flash-tube illumination through a mirror system to give the particle velocity in a fluid. J. E. CAFFYN

532.52 : 535.551

3341. Orientation by flow of rigid particles which repel each other. Application to dynamic birefringence. M. JOLY. *J. Phys. Radium*, **12**, 900–11 (*Dec.*, 1951) *In French.*

In previous theories of orientation of particles by flow the interaction between the particles has been neglected. Following closely the two-dimensional theory of Boeder, an interaction term is introduced into the distribution function for the flow of asymmetrical, rigid, charged particles. The spatial theory of Peterlin is then considered. In each case the new distribution function differs from that obtained without the effect of interaction by the replacement of the rotatory diffusion constant D of the particles by an apparent constant D'. The relationship between D and D' is given in terms of the mean value of the potential barrier which a particle must exceed in order to turn about its centre of gravity by 180°. D' is less than D. The new flow birefringence equations giving the amount of double refraction and the extinction angle χ are discussed. The deduction of the particle size and the intensity of their interaction from the value of χ is described. The problem is treated when polydispersity is present and in this case the method of evaluation from flow birefringence measurements of the size of the frequency maxima of the particles, the degree of polydispersion of the system and the mean value of the interaction is indicated. H. G. JERRARD

532.525

3342. Studies on the critical even jet. C. ROUMIEU. *C.R. Acad. Sci.* [*Paris*] **234**, 52–4 (*Jan.* 2, 1952) *In French.*

The method of finite differences is applied to the flow of a compressible fluid and used in a study of the critical jet. T. C. TOYE

532.525 : 536.7 : 541.124

3343. Note on the application of near-frozen flow criteria for one-dimensional nonviscous expansion through a level nozzle. S. S. PENNER. Letter in *J. Chem. Phys.*, **20**, 341 (*Feb.*, 1952).

Addition to a previous paper [Abstr. 6772 (1951)] expanding an equation and giving an explicit relation for T_c–T'. C. TURNER

532.527

3344. Momentum equations of the boundary layer, and their application to the turbulent boundary layer. B. HUDIMOTO. *Mem. Fac. Engng Kyoto Univ.*, **13**, 162–73 (*Oct.*, 1951).

A momentum equation relating to the boundary layer, similar to that derived by Kármán, obtained by

applying the law of moment of momentum, is applied to discuss the velocity distribution of turbulent flow in the boundary layer. A method of calculating boundary layer thickness, simpler than that proposed by Buri, is discussed, and applied to experimental results obtained by Gruschwitz; satisfactory agreement is found between theoretical and experimental results. J. S. G. THOMAS

532.542

3345. Flow through uniformly tapped pipes. B. G. VAN DER HEGGE ZIJNEN. *Appl. Sci. Res.*, **A3**, 144–62 (*No.* 2, 1951).

The problem treated relates to parallel multi-tube reactors, spray systems in de-waxing units, pipe burners for gaseous fuels, sprinkling systems for insecticide spraying, fire prevention and irrigation, ventilating systems in buildings and vehicular tunnels, distributing pipes in water filtering and aerating systems, etc., where it is required to ascertain under what conditions the discharge can be uniformly distributed over the manifold length. After a review of the case of laminar and turbulent flow through a pipe with a porous wall, the following questions have been treated in an analytical way: laminar flow in a pipe and laminar flow through branch pipes, or with discharge through orifices; turbulent flow in a pipe and laminar flow through branch pipes, or discharge through orifices. A.

532.582.2

3346. Note on Rayleigh's problem for a bent flat plate. H. HASIMOTO. Note in *J. Phys. Soc. Japan*, **6**, 400–1 (*Sept.–Oct.*, 1951).

A plate in the form of two semi-infinite planes intersecting at an arbitrary angle is considered to be moved impulsively from rest with a constant velocity parallel to the line of intersection, in viscous incompressible fluid initially at rest. Formulae are given for the skin friction in the subsequent motion. J. G. OLDROYD

532.592

3347. Reflection of waves in a channel of variable depth. M. ROSEAU. *C.R. Acad. Sci.* [*Paris*] **234**, 297–9 (*Jan.* 14, 1952) *In French.*

Continuation of previous work [Abstr. 803–4 (1952)]. The ratio of the amplitudes of stationary waves at the two level ends of the channel, and the coefficient of reflection of a progressive wave approaching the continuous change in depth, are calculated. J. G. OLDROYD

CAPILLARITY 532.6

532.6 : 533.15

3348. Diffusion and flow of gases and vapours through micropores. IV. Flow of capillary condensate. P. C. CARMAN. *Proc. Roy. Soc. A*, **211**, 526–35 (*March* 20, 1952).

For Pt III, see Abstr. 9325 (1951). If capillary condensation occurs in a porous plug and a steady pressure difference of an adsorbed gas is maintained across the plug, capillary condensate behaves as if it were bulk liquid in viscous flow through the pore-space. The driving force producing flow is not the pressure difference of the gas, but a very much larger difference of capillary pressure resulting from this pressure difference, presumably due to action of surface tension at curved menisci in the pores. The mechanism contrasts sharply with flow in adsorbed films, which has earlier been shown to conform to a process of surface diffusion. In a saturated plug, observed permeabilities agree very well with calculated values, assuming capillary condensate has the viscosity and density of bulk liquid. Apart from confirming the mechanism of flow, this suggests that liquid properties are not much altered in capillaries of radii down to at least 20 Å. At a given mean pressure of gaseous adsorbate, the permeability has a very different value if the pressure is approached by desorption from a saturated plug from that when the pressure is approached by adsorption from a degassed plug. This is because, due to adsorption hysteresis, the saturation of the plug is different in the two experiments. For a given degree of saturation, the permeability is the same in both adsorption and desorption runs. A.

532.6 : 533.15

Diffusion and flow of gases and vapours through micropores. *See Abstr.* 3348

532.612

3349. Surface tension of alkyl halides. J.-F. JOLIET. *C.R. Acad. Sci.* [*Paris*] **234**, 322–4 (*Jan.* 14, 1952) *In French.*

A formula involving empirical constants is suggested, by which the surface tension of $H–(CH_2)_n–X$ compounds (X = halogen atom, $n \geqslant 4$) can be calculated. A. J. TAYLOR

532.612.4

3350. On the theory of surface tension of regular solution. T. MURAKAMI, S. ONO, M. TAMURA AND M. KURATA. *J. Phys. Soc. Japan*, **6**, 309–12 (*Sept.–Oct.*, 1951).

By using the quasi-crystalline model, the grand partition function of a binary solution, in which the molecular fractions are considered to be functions of the distance from the surface, is constructed. And the concentration is determined so as to make the system be in thermodynamical equilibrium. The surface tension and the surface excess amounts of components obtained in such a manner does not conflict with the Gibbs adsorption formula. Guggenheim's theory of the surface tension of regular solution, based on the monolayer model, is a special case of the present theory. The monolayer theory however, is in contradiction with the Gibbs formula, since the system cannot reach equilibrium state if the difference of composition from the bulk phase is confined to such a thin region as mono- or two-molecular layer. A.

532.65

3351. Viscous energy dissipated during the atomization of a liquid. G. W. MONK. Letter in *J. Appl. Phys.*, **23**, 288 (*Feb.*, 1952).

Assuming the droplets formed from a liquid thread, a rough calculation of viscous energy dissipated in producing the thread is made. J. E. CAFFYN

MOLECULAR THEORY OF LIQUIDS 532.7

532.7 : 539.13

3352. The determination of intermolecular energy constants from common physicochemical properties of liquids. E. A. MOELWYN-HUGHES. *J. Phys. Coll. Chem.*, **55**, 1246–54 (*Oct.*, 1951).

If the energy of interaction, ϕ, of two molecules can be represented as the sum of two inverse-power functions of their separation, a, it becomes necessary to determine the four constants of the equation $\phi = Aa^{-n} - Ba^{-m}$. This article offers a method for determining them from readily accessible properties of a liquid at, or subcooled below, its freezing-point. The product (mn) is obtained by the method of Born and Landé. The sum ($m + n$) is obtained from an expression governing the variation of isothermal compressibility with respect to pressure, and is confirmed by an application of Grüneisen's law, of which a statistical derivation is given. Values of m and n are thus found without making prior assumptions concerning either. The remaining constants, A and B, are then readily evaluated from a knowledge of the co-ordination number. The method is applied to liquid Hg, with satisfactory results. A.

532.72 : 535.417

3353. Investigation on diffusion in liquids by means of a polarization interferometer. V. N. TSVETKOV. *Zh. Eksper. Teor. Fiz.*, **21**, 701–10 (*No.* 6, 1951) *In Russian.*

Discusses the theory of the new method according to which the diffusion coefficient can be measured with an accuracy of 3–5% when the diffusion cell is 1 cm thick and the refractive index difference is 5×10^{-5}. An experimental investigation on solutions of low-molecular substances (sugar in water, *p*-oxyanisole in benzene) and of polymers (divinylstyrol in benzene, and in dichloroethane) was conducted, and the diffusion coefficients of the solutes were determined. F. LACHMAN

532.72

3354. On the theory of extraction from falling droplets. II. R. KRONIG, B. VAN DER VEEN AND P. IJZERMAN. *Appl. Sci. Res.*, **A3**, 103–10 (*No.* 2, 1951).

For Pt I, see Abstr. 4759 (1950). The theory of extraction of a substance, dissolved in droplets of a fluid, when these are falling (or rising) in another fluid under the influence of gravity, is specialized for the case that the rate of falling (or rising) is very small. A perturbation method, well known from quantum mechanics, is applied to determine the time of diffusion in second approximation. A.

532.74 : 539.312

3355. Interaction of polymers and mechanical waves. W. O. BAKER AND J. H. HEISS. *Bell Syst. Tech. J.*, **31**, 306–56 (*March*, 1952).

New techniques of Mason, McSkimin, Hopkins and co-workers for generation of shear waves over the frequency range 2×10^2 to $2{\cdot}4 \times 10^7$ c/s have been used to study mechanical properties of chain polymers. Polymer solids, melts and dilute solutions, representing the main states in which plastics and rubbers are fabricated or used, were explored to find the characteristic relaxation times, rigidities and viscosities of various chemical structures. Polyisobutylene, hevea rubber, polydimethyl siloxane, vinyl chloride-acetate copolymers and plasticized nitrocellulose were compared with polyethylene and polyamides as examples of the range of solid properties encountered. As melts, several polyisobutylenes, polybutadiene, polypropylene, polypropylene sebacate and poly-α-methyl styrene were investigated as models for varying degrees of chain substitution. Chain rigidity in, for instance, polyisobutylene, seemed to reflect viscoelastic overall configurational changes up through the kilocycle range, but nearest-neighbour interactions took over in the megacycle region, leading to moduli of 10^9 dynes/cm² even for syrupy fluids. In dilute solution, polyisobutylene, polystyrene, natural rubber and polybutadiene microgel exhibited characteristic dynamic viscosities and rigidities depending linearly on concentration. Presumably, this reflects mechanical properties of isolated chains. Some possible models were suggested for the frequency dependence of such properties. A.

532.77

3356. Cryoscopy in fused lithium borate. G. ZARZYCKI. *C.R. Acad. Sci.* [*Paris*] **234**, 95–7 (*Jan.* 2, 1952) *In French.*

From the thermal diagram for Li_2O and B_2O_3 dissolved in fused lithium metaborate, the equilibrium, $Li_2B_2O_4 \rightleftharpoons B_2O_3 + 2Li^+ + O^{=}$, is established. No information is obtained on the state of B_2O_3. Analogies for the ionization of Li_2O are given by a corresponding comprehensive diagram for Fe_2O_3, Co_2O_3, Al_2O_3, Cr_2O_3, MgO and GlO in fused lithium borate. The result is claimed to be general for other oxygen solvents such as silicates, aluminates and phosphates. H. H. HODGSON

MECHANICS OF GASES 533

533.15

3357. Diffusion coefficient of sodium vapor in nitrogen. R. J. CVETANOVIĆ AND D. J. LE ROY. Letter in *J. Chem. Phys.*, **20**, 343–4 (*Feb.*, 1952).

Describes a method of determining the diffusion coefficient of Na vapour in N; the value obtained for the temperature of 253·5°c and expressed in terms of values calculated for a total pressure of 1 atm is $0{\cdot}68 \pm 0{\cdot}03$ cm²sec^{-1}. F. LACHMAN

533.15

3358. Diffusion coefficients of the systems CO_2–CO_2 and CO_2–N_2O. I. AMDUR, J. W. IRVINE, JR, E. A. MASON AND J. ROSS. *J. Chem. Phys.*, **20**, 436–43 (*March*, 1952).

The radioactive tracer, $C^{14}O_2$, has been used to measure diffusion coefficients for the systems CO_2–CO_2 and CO_2–N_2O in the temperature range −78° to 90°c. The apparatus, which is the Loschmidt type, uses saturation ionization currents as a measure of the extent of diffusion. The characteristics of this type of apparatus have been analysed in detail to obtain working equations which permit use of experimental

measurements at both small and large values of the time. The present results, whose accuracy is estimated at 1·5%, agree with those obtained by other investigators using different experimental methods. Although the difference is small, $2{\cdot}6 \pm 0{\cdot}3\%$, the diffusion coefficient for the system CO_2–N_2O is consistently larger than that for CO_2–CO_2 over the entire temperature range. A.

533.15

3359. The flow of gases through capillaries. J. A. W. Huggill. *Proc. Roy. Soc. A*, **212**, 123–36 (*April* 8, 1952).

The flows of hydrogen, helium, nitrogen, ethylene, argon and carbon dioxide through capillaries have been measured at room temperature in the region of transition between molecular and viscous flow for capillary walls of polymethylmethacrylate and gold. Large numbers of capillaries were used in parallel, each from 2 to 3 mm long and about 0·08 mm in diameter. The minima in the curves found by earlier observers were confirmed, and comparisons with kinetic theory showed discrepancies depending on the gas and wall material. The differential flows of the mixtures nitrogen/carbon-dioxide, argon/carbon-dioxide and nitrogen/ethylene were determined by measurement of the change of concentration during effusion through similar capillaries, and the discrepancies with kinetic theory were confirmed. Results are compared with recent theories, and the separation at high pressures due to differing collision diameters is verified. Since flows were lower than predicted, any explanation of the discrepancies based on specular reflection is questioned. A.

533.15 : 533.6.013.22

3360. Diffusion in a field of homogeneous turbulence. II. The relative motion of particles. G. K. Batchelor. *Proc. Camb. Phil. Soc.*, **48**, 345–62 (*Pt* 2, 1952).

In an earlier paper [Abstr. 124 (1951)] the author considered the problem of the turbulent diffusion, relative to a fixed origin, of a cloud of marked fluid whose initial position is given. This was found to be determined by the initial shape of the cloud and the statistical properties of the displacement of a single fluid particle. The present paper is concerned with the relative diffusion of the cloud, i.e. with the tendency to change its shape, or, more precisely, with that part of the relative diffusion which is described by the probability that a given vector y can lie with both its ends in marked fluid at time t. This aspect of the relative diffusion is found to be determined by the initial shape of the cloud and the statistical properties of the separation, at time t, of two fluid particles of given initial separation. The statistical functions introduced to describe the relative diffusion are found to be related to Richardson's distance-neighbour function. The relative diffusion of two particles is a more complex problem than diffusion of a single particle about a fixed origin because the relative diffusion depends on the initial separation. The closer the particles are together, the smaller is the range of eddy sizes that contributes to their relative velocity; for the same reason, relative diffusion is an accelerating process, until the particles are very far apart and wander independently. The hypothesis is made that if the initial separation is small enough, the probability distribution of the separation will tend asymptotically to a form independent of the initial separation before the particles move independently. This hypothesis permits various simple deductions, some of which make use of Kolmogoroff's similarity theory. The important question of the description of the relative diffusion by a differential equation is examined; Richardson has put forward one suggestion, and another, based on a normal distribution of the separation, is made herein. A.

533.5

3361. The achievement of a rarefied atmosphere of given characteristics. P. Romann. *Vide*, **6**, 1064–7 (*July–Sept.*, 1951) *In French.*

Gives description and mathematical analysis of a device for introducing small quantities of gas at known pressures into an evacuated apparatus.

L. G. CARPENTER

533.5 : 537.583

3362. Ionization gauge with thoria-coated cathode. O. A. Weinreich and H. Bleecher. Note in *Rev. Sci. Instrum.*, **23**, 56 (*Jan.*, 1952).

Thoria-coated iridium or rhodium wires are very suitable for ionization gauge cathodes since they are not damaged by exposure to the atmosphere when hot and will operate stably in pressures of 10^{-2} mm O_2. A typical gauge is described. A. H. W. BECK

533.5

3363. Differential methods of vacuum leak detection. G. Nief. Letter in *Brit. J. Appl. Phys.*, **3**, 29 (*Jan.*, 1952).

A device for leak detection consists of one ionization gauge protected by a liquid air trap. The presence of the leak-testing gas, whose vapour pressure must be negligible at liquid air temperature, is detected by the drop in pressure. Compensations for manometer fluctuations due to variable pumping speeds, gas evolution from walls, unsteady rate of flow of leaks and fluctuations in gauge cathode emission are discussed. At residual pressure of 5×10^{-5} mm Hg a pressure variation of 2×10^{-8} can be observed.

G. WITTENBERG

533.5 : 535.34–32

3364. Application of optical absorption in the far ultra-violet to the detection of leaks in vacuum apparatus and to the measurement of low pressures. J. Romand, V. Schetzoff and B. Vodar. *Vide*, **6**, 1046–51 (*July–Sept.*, 1951) *In French.*

The glass gauge described is based on the principle that the response of a photoelectric cell on which is incident a beam of short wavelength (1 200–1 850 Å) ultraviolet light, which has traversed a column of gas, depends on the nature and pressure of the gas and on the thickness of the column. Details of the construction of the gauge and the results of some preliminary tests are given. The light source is an uncooled hydrogen lamp with a fluorite window, and the receiver, a Pt photoelectric cell (threshold 2 000 Å) with a quartz window, is connected to a specially designed amplifier. The thickness of the gas column is variable. Calibration curves for air are given.

Using benzene, a leak of 2×10^{-6} litre/sec in a glass apparatus, to which the gauge was attached, was detected. S. WEINTROUB

533.5 : 621.317.79

3365. A new circuit for ionization vacuum gauge. H. SIBATA, Y. TUZI AND H. KUMAGAI. Note in *Rev. Sci. Instrum.*, **23**, 54–5 (*Jan.*, 1952).

The object is to measure directly the ratio of ion current to electron current, obviating the necessity for keeping the latter constant. The circuit, in which two triodes are employed, saves maintenance, improves the speed of measurements and is highly sensitive. G. WITTENBERG

533.51

3366. Note on the speed measurements of rotary vacuum pumps. H. KUMAGAI, H. SIBATA AND Y. TUZI. Note in *Rev. Sci. Instrum.*, **23**, 56–7 (*Jan.*, 1952).

The pumping speed of a rotary pump of large capacity was observed to be less than its free air displacement when the volume of the attached vessel was less than the inner volume of the pump. This phenomenon is explained by consideration of the geometry of the pumping system. G. WITTENBERG

533.6.01 : 534.222.2

3367. On the two flow fields behind a forked compression shock. W. KOFINK. *Ann. Phys.* [*Lpz.*] **9**, 401–5 (*No.* 8, 1951) *In German.*

The mathematical discussion of Abstr. 9332 (1951) is extended to include the flow behind the shock wave. General expressions for the ratio of the velocities, the densities and the cross-sections, and for the entropy difference on either side of the boundary line between the two flows are obtained. A particular mathematical (not physical) case is considered for which the equation of the 6th degree reduces to a quadratic and 4 linear equations giving values for the roots which may be used as initial values for the solution of the equation in the general case. S. WEINTROUB

533.6.011

3368. On some exact solutions of the two-dimensional steady flow of compressible fluid. O. SAITO. *J. Phys. Soc. Japan*, **6**, 248–54 (*July–Aug.*, 1951).

In continuation of previous work [Abstr. 132 (1951)] in which a new method of solving the differential equations of two-dimensional steady flow of compressible fluid was discussed, some details of the mode of solution of the equations are filled in, and two exact solutions of the equations are discussed; one solution represents supersonic flow, the other subsonic flow. Velocity, q, and stream function, ϕ, are used as independent variables. In general, an ∞ value of the velocity gradient or stream line cusps occur only in supersonic flows provided the flow is curved. J. S. G. THOMAS

533.6.011.3

3369. On the asymptotic behaviour of three-dimensional compressible fluid flow at a great distance from a body. I. H. HASIMOTO. *J. Phys. Soc. Japan*, **6**, 383–7 (*Sept.–Oct.*, 1951).

The steady irrotational isentropic continuous subsonic flow of a perfect gas past an arbitrary three-dimensional body with arbitrary distribution of sources on its surface is considered. Based on the thin-wing-expansion method, the velocity potential Φ is expanded in the form $\Phi = U(x + A_1 r^{-1} + A_2 r^{-2} + \ldots)$, $A_1 = a_0 f^{-1}$, $A_2 = f^{-3}[a_{10}\cos\theta + \sin\theta\,(a_{11}\cos\omega + a_{1-1}\sin\omega)]$, $f = (1 - M^2\sin^2\theta)^{1/2}$, where U is the velocity of the undisturbed flow of Mach number M streaming in the positive direction of x-axis, and $x = r\cos\theta$, $y = r\sin\theta\cos\omega$, $Z = r\sin\theta\sin\omega$. Using this expression, the force (X, Y, Z) and moment (M_x, M_y, M_z) experienced by the body are found to be: $X = \rho_\infty Q_\infty U$, $Y = Z = 0$, $M_x = 0$, $M_{y,\,z} = \pm 4\pi a_1$, $\pm_1\rho_\infty U^2/(1 - M^2)^{-1}$, where $\rho_\infty Q_\infty$ is the total strength of sources, and ρ_∞ the density at infinity. A.

533.6.013.22

3370. Experimental study of the spectrum of isotropic turbulence. I. H. SATO. *J. Phys. Soc. Japan*, **6**, 387–92 (*Sept.–Oct.*, 1951).

Some measurements were made on the turbulence behind the grid. The wind-tunnel is of the single open-jet type and the range of test section covers from 20 to 70 times of mesh length. In the first place, the decay of total energy is proved to be inversely proportional to the distance from grid. The energy spectrum which is observed at various positions on the centre line, is nearly the same as those previously reported. The decay of spectral components was measured directly by moving the hot-wire anemometer along the wind-tunnel axis. In the low wave number region, energy decay follows the inverse power law. But at high wave number, decay is severer at first and gradually reaches the state of energy equilibrium. The last result seems to be influenced by free jet mixing. A.

533.6.013.22

3371. The relations between the correlation functions for the velocity in homogeneous and isotropic turbulence. E. MATTIOLI. *Atti. Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **11**, 260–4 (*Nov.*, 1951) *In Italian.*

Mathematical. The von Kármán equation [*J. Roy. Aero. Sci.*, **4**, 131–8 (1937)] is obtained by two methods; by applying the principle of continuity to a hemisphere and by using the analogy between the correlation and stress tensors. The latter method is used to derive alternative expressions for the two von Kármán–Howarth equations [*Proc. Roy. Soc. A*, **164**, 192–215 (1938)]. S. WEINTROUB

533.6.013.22 : 534.232

3372. On sound generated aerodynamically. I. General theory. M. J. LIGHTHILL. *Proc. Roy. Soc. A*, **211**, 565–87 (*March* 20, 1952).

A theory is initiated, based on the equations of motion of a gas, for the purpose of estimating the sound radiated from a fluid flow, with rigid boundaries, which as a result of instability contains regular fluctuations or turbulence. The sound field is that which would be produced by a static distribution of acoustic quadrupoles whose instantaneous strength per unit volume is $\rho v_i v_j + p_{ij} - a_0^2\rho\delta_{ij}$, where ρ is the density, v_i the velocity vector, p_{ij} the compressive stress tensor, and a_0 the velocity of sound outside the

flow. This quadrupole strength density may be approximated in many cases as $\rho_0 v_i v_j$. The radiation field is deduced by means of retarded potential solutions. In it, the intensity depends crucially on the frequency as well as on the strength of the quadrupoles, and as a result increases in proportion to a high power, near the eighth, of a typical velocity U in the flow. Physically, the mechanism of conversion of energy from kinetic to acoustic is based on fluctuations in the flow of momentum across fixed surfaces, and it is explained how this accounts both for the relative inefficiency of the process and for the increase of efficiency with U. It is shown how the efficiency is also increased, particularly for the sound emitted forwards, in the case of fluctuations convected at a not negligible Mach number. A.

MOLECULAR THEORY OF GASES 533.7

533.7

3373. The velocity distribution of singly scattered molecules in gases. J. W. Hiby and M. Pahl. *Z. Phys.*, **130**, 348–55 (*No.* 3, 1951) *In German.*

This has been evaluated, by graphical integration, as a function of the deflection of the molecules from the direction of the primary beam. The "persistence of molecular velocities," determined from the velocity distribution and the probability distribution for the direction of collision partners [Abstr. 128 (1952)], coincides with Jeans' values. A. GELBTUCH

533.7

3374. The second virial coefficient of non-spherical molecules. T. Kihara. *J. Phys. Soc. Japan*, **6**, 289–96 (*Sept.–Oct.*, 1951).

The Lennard–Jones model of molecules of spherical symmetry has been generalized to non-spherical models without sacrificing analytical integrability of the second virial coefficient. The essential generalization consists in the definition of the intermolecular distance, ρ, the intermolecular potential, U, being supposed to be a function of ρ only and

$$U(\rho) = U_0\left[\frac{m}{n-m}\left(\frac{\rho_0}{\rho}\right)^n - \frac{n}{n-m}\left(\frac{\rho_0}{\rho}\right)^m\right],\quad n>m>3.$$

As the simplest extension ρ is defined by the shortest distance between molecule cores, in which thin rods (disks) are adopted in case of prolonged (flat) molecules. Next, ρ is so defined that the model becomes an attracting spheroid. For these models the second virial coefficient has been integrated analytically and tabulated. The model constants have been determined for H_2, N_2, C_2H_4 and CO_2. A.

533.7

3375. The droplet model of real gases. F. Kuhrt. *Z. Phys.*, **131**, 185–204 (*No.* 2, 1952) *In German.*

By considering a model of a real gas wherein small clusters of molecules form nuclei for condensation, formulae are produced which are similar to those of Mayer's treatment for a perfect gas. T. C. TOYE

533.7

3376. The droplet model of a supersaturated real gas. F. Kuhrt. *Z. Phys.*, **131**, 205–14 (*No.* 2, 1952) *In German.*

An extension of the work described in the preceding abstract to a supersaturated real gas. T. C. TOYE

533.7

3377. Ion clustering. S. Bloom and H. Margenau. *Phys. Rev.*, **85**, 670–3 (*Feb.* 15, 1952).

Kinetic theory is employed in investigating the extent to which polarizable molecules attach themselves to slowly moving ions in a gas, the underlying picture being that commonly used in deriving the barometric equation, i.e. the aggregation of molecules in a constant field of force. A potential energy of the form $-\kappa r^{-4}$ for $r \geqslant r_0$ but ∞ for $r \leqslant r_0$, leads to a large cluster formation. This hard-sphere potential, however, packs most of the clustered molecules into the sharp crevasse near r_0 and therefore falsifies the result. When the cusp is removed by the more adequate potential $\lambda r^{-12} - \kappa r^{-4}$, the tendency to cluster is reduced nearly 100-fold. Results are obtained in general agreement with experiment, except for $Li^+ - Kr$, where theory predicts a much smaller cluster than that inferred from mobility measurements. A.

533.7

3378. Radial distribution function of a gas of hard spheres and the superposition approximation. B. R. A. Nijboer and L. Van Hove. *Phys. Rev.*, **85**, 777–83 (*March* 1, 1952).

The term $g_2(r)$ proportional to the square of the density in the expansion of the radial distribution function $g(r)$ of an imperfect gas in powers of the density is calculated exactly in the case of a gas consisting of hard spheres. The result is checked by means of Boltzmann's value of the 4th virial coefficient of such a gas. The integral equation for $g(r)$, obtained on applying the superposition approximation introduced by Kirkwood and by Born and Green, can also be solved by an expansion in powers of the density. For the case of hard spheres the approximate $g_2'(r)$ found in this way is compared with the exact $g_2(r)$. As a further application of the result on $g_2(r)$ a certain integral is discussed, which is of interest in the treatment of interference effects in neutron scattering problems. A.

533.73 : 536.7

Theory of transit phenomena based on the principle of superposition. *See Abstr.* 3553

533.75

3379. The experimental determination of the equation of state data of gases at temperatures between 0°C and −180°C. A. Michels, T. Wassenaar and T. N. Zwietering. *Physica*, **18**, 67–74 (*Jan.*, 1952).

A new method is described. In essence it is based on the measurement of isochores for a series of densities by the use of a new type of a differential manometer. These densities are computed from known data of state above room temperature. To test the performance of the apparatus, measurements on air have been carried out in the range from 0°c to

−155°c. The reproducibility of the data was of the order 1 : 10 000. A.

VIBRATIONS . ACOUSTICS 534

534.01

3380. Transient vibration of linear multi-degree-of-freedom systems by the phase-plane method. R. S. AYRE. *J. Franklin Inst.*, **253**, 153–66 (*Feb.*, 1952).

This paper shows the application of phase-plane graphical methods to transient forced vibrations of undamped, linear systems having more than one degree of freedom. Lumped parameter as well as distributed parameter systems are included. An introductory application to a single-degree-of-freedom system is followed by examples relating (1) to the two-degree-of-freedom two-mass system, (2) to the two-degree-of-freedom single-mass system with inertia coupling, and (3) to a simply supported uniform beam. The essential feature is the independent application of the phase-plane method to each normal co-ordinate of a system. A.

534.015

3381. On the interaction of non-linear oscillations. N. MINORSKY. *C.R. Acad. Sci.* [*Paris*] **234**, 292–4 (*Jan.* 14, 1952) *In French.*

A non-linear differential equation, which represents the combination of two types of oscillation, associated with the equations of Mathieu and van der Pol respectively, is studied by a perturbation method.

J. G. OLDROYD

534.1

3382. The asymptotic distribution of the eigenvalues and eigenfunctions of a general vibration problem. L. GÅRDING. *K. Fysiogr. Sallsk. Lund. Forh.*, **21**, 10 *pp.* (*No.* 11, 1951).

The problem treated comprises vibration problems obtained by substituting for the $(\partial/\partial x + \partial/\partial y)$ operator in the equation of a vibrating membrane fixed along its boundary, any self-adjoint elliptic differential operator with constant coeff. in any number of variables. The asymptotic formulae derived apply, in particular, to operators for which the degree exceeds the number of variables, and generalize R. Courant's and A. Pleijel's results for vibrating plates. A. GELBTUCH

534.2 : 535.12 : 538.56

3383. A demonstration of wave fronts, attenuation, and diffraction. W. C. MOORE. *Amer. J. Phys.*, **20**, 61–4 (*Feb.*, 1952).

The concept of wave fronts, defined as points of like phase, can be demonstrated by the use of an audiofrequency oscillator, a loudspeaker, a microphone and a cathode-ray oscilloscope. The shapes of wave fronts radiated from plane, line and point sources and the attenuation of intensity with distance can be qualitatively demonstrated. The double slit diffraction pattern can be explored as a function of the wavelength, slit spacing and distance to the plane of observation in a simple arrangement of equipment. A.

534.21

3384. Two-dimensional waves of finite amplitude in ideal gases. K. BECHERT AND H. MARX. *Z. Naturforsch.*, **6a**, 767–75 (*Dec.*, 1951) *In German.*

Propagation of acoustic waves in gases flowing in tubes and reflection of the waves from walls, open or closed ends, and boundaries of regions with different adiabatic constants (e.g. burnt and unburnt gas mixtures in combustion engines) is studied under the usual simplifying assumptions. Expansion in terms of $\Delta c_i/c_{ni}$ (where Δc_i is the velocity disturbance in the i-direction, in which the sonic velocity is c_{ni}) permits the use of the derived formulae in cases of relatively large amplitudes, where the acoustic approximation fails. Simple formulae are derived in terms of "reduced pressures" p_i/p_n, where p_i is the pressure disturbance characterizing a wave progressing only in the i-direction and p_n is the undisturbed pressure. A. GELBTUCH

534.21

3385. Transmission of ultrasonic waves through a thin solid plate at the critical angle for the dilatational wave. K. R. MAKINSON. *J. Acoust. Soc. Amer.*, **24**, 202–6 (*March*, 1952).

The transmission, through an isotropic solid plate immersed in a liquid, of ultrasonic waves incident at the critical angle for total reflection of the dilatational wave, is examined experimentally and theoretically. It has previously been held that total reflection does not occur at this angle when the thickness of the solid is less than or comparable with the wavelength of the dilatational wave in it. It is now shown that, owing to interference between the dilatational and rotational waves, total reflection does occur at or very near this angle for a considerable range of thickness in this region. It is therefore possible to use the total reflection method for the determination of the dilatational velocity in a solid even when only thin specimens of the solid are available. A.

534.213

3386. Spherical wave propagation in solid media. F. G. BLAKE, JR. *J. Acoust. Soc. Amer.*, **24**, 211–15 (*March*, 1952).

Divergent compressional waves in solids differ from similar waves in fluids, even though the particle displacement is parallel to the direction of propagation in both media. The wave propagating from a radially oscillating spherical cavity in an infinite solid medium sees an acoustic radiation impedance which is a function of the Poisson's ratio of the medium as well as of the usual parameters. The radiation resistance has the same form as in a fluid medium, but the reactance is a negative or stiffness reactance, except at high frequencies in media of low rigidity. When an impulsive pressure is generated in the cavity, as by an explosion, the form of the radiated pulse is a damped oscillating wave train which does not closely reproduce the original pressure pulse. A.

534.213.4

3387. Properties and application of cylindrical acoustic wave guides. J. MERHAUT. *Tesla Tech. Rep., No.* 1, 1–5 (*March*, 1951).

A theoretical waveguide development of the behaviour of cylindrical tubes from the theory of

exponential horns. The applications of the theoretical conclusions to acoustic waveguides and for the measurement of microphones are mentioned.

A. B. WOOD

534.22/.23

3388. The propagation of sound through gases contained in narrow tubes. L. E. LAWLEY. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 181–8 (*March*, 1952).

A comprehensive investigation is made into the validity of the Helmholtz–Kirchhoff equations for the absorption and velocity of sound in a gas contained in a narrow tube. Results are given for air, O, N and H contained in tubes of radii between 0·15 mm and 1·17 mm at frequencies between 60 and 150 kc/s. The form of both the velocity and absorption equations is confirmed, but the viscosity/thermal-conductivity constant is found experimentally to be about 5% above the theoretical value. A method is outlined in which the free space absorption can be calculated from measurements in a tube at varying pressures and results are given in the case of O. A.

534.22/.23

3389. New methods of ultrasonoscopy and ultrasonography. P. J. ERNST AND C. W. HOFFMAN. *J. Acoust. Soc. Amer.*, **24**, 207–11 (*March*, 1952).

Four groups of new methods of indirect ultrasonoscopy and ultrasonography are developed: those using temperature-sensitive chromotropic compounds, those using leucobases of dyes, those using thermostimulable phosphors and those using special temperature-sensitive phosphors. Various techniques are described and some results shown in the illustrations. Finally, a new method of direct ultrasonography is proposed. This method makes use of the possibility to detonate certain labile chemical compounds by ultrasonics. A.

534.22/.24

3390. Rotational dispersion in the velocity, attenuation, and reflection of ultrasonic waves in hydrogen and deuterium. E. S. STEWART AND J. L. STEWART. *J. Acoust. Soc. Amer.*, **24**, 194–8 (*March*, 1952).

Data are presented on the dispersion of the velocity of sound and on the effect of impurities upon the rotational relaxation times determined therefrom. The attenuation due to the relaxation is shown to agree with the theory, with some evidence of multiple relaxation. Anomalous dispersions of the classical attenuation and of the Herzfeld reflection coefficient are predicted. The latter is confirmed experimentally and also yields a determination of the accommodation coefficient. A.

534.22

3391. Velocity of ultrasonics of 960 kc/s in ethane in the region of the critical state. J. NOURY. *C.R. Acad. Sci.* [*Paris*] **234**, 303–5 (*Jan.* 14, 1952) *In French.*

The light diffraction method was used, and a minimum value was observed at the critical point.

G. F. HODSMAN

534.22 : 532.122

3392. The velocity of ultrasound and the compressibility of three typical non-ideal mixtures. A. SOKOLLU. *Istanbul Univ. Fen. Fak. Mec., Ser. A*, **16**, 162–73 (*July*, 1951) *In German.*

The velocity of ultrasound has been measured within the range 7·5–18 Mc/s on three liquid mixtures, viz. ethyl alcohol and water, acetic acid and water, and CS_2 and acetone. The first two mixtures showed maxima at specific concentrations of the first component, while at the third showed a minimum. If the attraction between two molecules A and B exceeds that between A and A or B and B, the mixture should show a contraction in volume giving a reduction of compressibility and hence an increase of the velocity of ultrasound. This contraction of volume also increases the density, which will affect the velocity in the opposite sense to the compressibility. When the change of compressibility exceeds that of the density, a velocity maximum would be expected, as occurred with the ethyl alcohol and acetic acid mixtures. When the attraction between molecules A and A or B and B exceeds that between A and B, an increase of volume occurs, giving an increase of compressibility and a reduction of the velocity of ultrasound, as occurred with CS_2 mixed with acetone. A. C. WHIFFIN

534.222.2 : 536.46

3393. Completion of the analysis of the structure of quasi-waves of shock and combustion. M. ROY. *C.R. Acad. Sci.* [*Paris*] **234**, 268–71 (*Jan.* 14, 1952) *In French.*

The structure of the reaction zone in a one-dimensional flame is discussed, preserving the notation and assumptions of a previous paper [Abstr. 2504 (1952)] dealing mainly with the pre-reaction zone. Detailed consideration is given to a flame in which the reaction is such that the relative temp. θ in the reaction zone increases linearly with the fraction of the reaction energy liberated. In this case, it is shown that the flame velocity u_1 is given by $u_1 = 4(1 - \theta_0/\theta_2)[\eta_1 A_m/3\rho_1(\theta_0 - 1)]^{\frac{1}{2}}$ where subscripts 1, 0, 2 refer respectively to the unreacted medium, the ignition point, and the reacted products, η_1 is the viscosity and ρ_1 the density of the unreacted gases. The quantity A_m is the max. reaction rate in the flame. Applying this equation to known flame speeds in air-kerosene mixtures at approx. N.T.P. leads to the conclusion that for this mixture reaction at the max. rate would be complete in 2–3 microsecs.

A. SCHOFIELD

534.23

3394. Sound absorption by perforated plates. J. B. SLAVIK, B. KLIMES AND V. ZADRAZIL. *Przegl. Telekomun., No.* 5, 139–43 (*May*, 1951) *In Polish.*

An interim report on experimental investigations of the theoretical formulae. The method of standing waves between two parallel plates was used. Good absorption was observed down to 300 c/s.

A. SCZANIECKI

534.23

3395. Measurement of the absorption of ultrasound in human skull bones and its dependence on frequency. T. F. HÜTER. Letter in *Naturwissenschaften*, **39**, 21–2 (*No.* 1, 1952) *In German.*

Impulses of 5–25 microsec duration within the frequency range 0·3 to 3·5 Mc/s were used and, as a result of the natural variation in the quality of the 35 bone specimens tested, considerable scatter occurred. The absorption in decibels varied linearly with thickness at a given test frequency, increasing

om 8 db at 0 mm (at 1·8 Mc/s) to 45 db at a thick-ss of 1 cm. The absorption coefficient (in db/cm) creased with frequency from 1 at 0·3 Mc/s to 68 at 5 Mc/s, but the variation was not linear throughout is range, minor variations occurring. A. C. WHIFFIN

534.23

96. The measurement of ultrasonic attenuation in lids by the pulse technique and some results in steel. . L. RODERICK AND R. TRUELL. *J. Appl. Phys.*, **23**, 7–79 (*Feb.*, 1952).

Pulse techniques for the measurement of attenuation solids have been extended and refined sufficiently obtain dependable measurements over a frequency nge from 5 to 50 Mc/s. Understanding of the lative importance of beam spreading, geometrical undaries and method of coupling has been im-oved. Coupling by means of water buffer and rect mounting is discussed in detail. Attenuation easurements in the frequency range from 5 to) Mc/s have been made on chrome molybdenum eel specimens, and these measurements have shown rge differences in ultrasonic attenuation for samples the same chemical composition but different heat eatment. The resulting differences are connected ith anisotropy which appears in the photomicro-aphs. The attenuation measurements are quite nsitive to heat treatment and other factors. The plication of the methods to metallurgical problems id the physics of solids is suggested. A.

534.23

97. Experimental investigations on the origin of e anomalous absorption of ultrasonic waves in quids. Y. WADA AND S. SHIMBO. *J. Acoust. Soc. mer.*, **24**, 199–202 (*March*, 1952).

There are two classes of liquids which show ano-alous absorption of ultrasonic waves, class A1 (non-sociated liquids) and A2 (associated liquids). In ixtures of two liquids of class A1, both density and und velocity vary almost linearly with concentra-on, in spite of the anomalous variation of sound sorption. The smaller the ultrasonic absorption of liquid of class A1, the greater is the decrease of sorption per unit concentration in a dilute benzene lution of the liquid. This does not hold in liquids class A2, such as alcohols. The inverse correlation tween the absorption of ultrasonic waves and infra-d radiations was found in the case of liquids of ass A1. It was concluded from the above facts that e absorption of ultrasonic waves in non-associated quids should be a result of the so-called "molecular sorption," in the same way as in gases. In the case associated liquids some part of the absorption is obably ascribed to the molecular absorption, but the maining part may be caused by another relaxation echanism, a slow change in local order of molecules. ne contribution of the molecular absorption to that highly viscous liquids, is also estimated. A.

534.232

98. Radiation loading of a piston source in a ite circular baffle. R. B. WATSON. *J. Acoust. Soc. ner.*, **24**, 225–8 (*March*, 1952).

Experimental data are exhibited for the radiation ading of a piston source enclosed in a circular finite ffle of dimensions of the order of the wavelength. A partial explanation of the data is given in terms of the direct radiated wave from the piston source, the diffracted wave arising at the edge of the baffle, and the wave arising from vibration of the baffle. The effect of flexural vibration of the piston source is shown to increase the radiation loading appreciably. Examination of the theoretical attempts to evaluate the radiation loading shows the lack of suitable expressions for calculation. A.

534.232 : 533.6.013.22

On sound generated aerodynamically. *See Abstr.* 3372

534.232 : 621.395.62

3399. The frequency response of barium titanate transducers. T. F. HUETER AND E. DOZOIS. Letter in *J. Acoust. Soc. Amer.*, **24**, 85–6 (*Jan.*, 1952).

The response curves of a large number of transducers operating on the thickness mode and radiating into water show a subsidiary peak at a slightly higher frequency than the main resonance. This is believed to be due to the excitation of a shear mode that has a thickness component, and the ratio of the frequencies is $\{2[(1-2\sigma)/(1-\sigma)]\}^{\frac{1}{2}}$, where σ is Poisson's ratio. G. L. WILSON (R)

534.3

3400. Modes, nodes, and antinodes. R. W. YOUNG. *Amer. J. Phys.*, **20**, 177–83 (*March*, 1952).

Student comprehension of certain facts of acoustics is handicapped by conflicting meanings of words used in the teaching of elementary physics. The words partial, overtone and harmonic are often treated as synonymous with normal mode of vibration. That normal modes are not always harmonic is illustrated by data given for an actual piano string. Vibration antinodes are not always equally spaced in tubular resonators of varying cross-section. Elementary textbooks often devote considerable space to the just scale, even though there is almost no experimental evidence that just scales are employed in actual music. Terminology to clarify matters is recommended. A.

534.322.3 : 612.014.45

3401. Sound and ultrasonics in mechanics and aviation. P. BUGARD, M. GUENNEC AND J. SELZ. *Ann. Télécommun.*, **7**, 47–56 (*Jan.*, 1952) *In French.*

Reproductions are given of the sound spectrum (0–100 kc/s) produced by various sources of high intensity. These include a circular saw, a wood planer, a piston-engined aircraft, a jet aircraft and a gas turbine. The aircraft were on the ground and measurements were made at a number of positions round them and also in the pilot's cockpit. The physiological effects of some of these intense sonic fields are briefly described. H. J. H. STARKS

534.39 : 532.623

3402. Study of the degassing of liquids under the action of ultrasonic vibrations of 80 and 17·7 kc/s. B. DEROUET. *C.R. Acad. Sci.* [*Paris*] **234**, 71–3 (*Jan.* 2, 1952) *In French.*

A study of the formation of air bubbles in water under the action of ultrasonic vibrations. A possible theory for bubble formation is produced and the minimum radius of bubble calculated. T. C. TOYE

534.39 : 542.952.7

Depolymerization by ultrasound. *See Abstr.* 3093

534.522

3403. Demonstration of stationary waves in a free sound field and a simple receiver for short sound waves. R. W. Pohl. *Naturwissenschaften*, **38**, 486–90 (*No.* 21, 1951) *In German.*

A description is given of a sound source for cm-waves—a small pipe, blown at 1 to 1·5 atm., at the focus of a concave reflector. A radiometer type of receiver responds well to these short waves. The parallel beam from the above sound source is directed almost tangentially on the surface of a liquid (water or petrol) in a shallow glass-bottomed tray. After reflection the sound waves fall on another reflector almost perpendicular to the plane of the liquid and facing the sound source, setting up a system of stationary waves which "corrugate" the liquid surface. A small arc lamp below the tray forms a corresponding pattern on the ceiling of the lecture room. A second method is also described in which the sound field is not limited by the liquid surface, but is transmitted through a liquid film on to the reflecting mirror. A demonstration is given using soap films inclined at different angles to the incident sound beam. A. B. WOOD

534.522.1

3404. Ultrasonic grating remaining after stopping the supersonic waves. A. Carrelli and F. Porreca. Letter in *Nuovo Cim.*, **9**, 90–1 (*Jan.*, 1952).

It has been found that the even-order fringes in the diffraction pattern of an ultrasonic grating, in a colloidal solution of starch in water ($\rho = 0{\cdot}1$ g/l) remain visible for several seconds after stopping the ultrasonic generator, whilst the odd-order fringes disappear immediately. The effect is only noticed with standing waves. G. F. HODSMAN

534.522.1 : 535.42

Diffraction of light by standing ultrasonic waves. *See Abstr.* 3506–7

534.522.5

3405. Geometrical and graphical representations of Lissajous figures. E. F. Fahy and F. G. Karioris. *Amer. J. Phys.*, **20**, 121–3 (*March*, 1952).

The fact that a sine curve, wrapped on the surface of a circular cylinder and projected orthogonally on a plane, will in certain cases produce Lissajous figures is used to develop a simple geometrical model which will demonstrate these curves. It is pointed out that natural generalizations of Lissajous figures can be obtained through this model. The use of sine-sine graph paper for plotting and analysing Lissajous figures is also described. A.

534.6 : 534.862.3 : 621.317.2—182.3

3406. The design of mobile electronic laboratories. P. H. Parkin. *J. Sci. Instrum.*, **29**, 8–11 (*Jan.*, 1952).

Discusses the design criteria with particular reference to the Building Research Station mobile acoustics laboratory. Size, power supplies, lay-out of apparatus and services (heating, lighting, etc.), are dealt with in detail. A.

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 4067–73.

534.78

3407. Control methods used in a study of the vowel G. E. Peterson and H. L. Barney. *J. Acoust. Soc. Amer.*, **24**, 175–84 (*March*, 1952).

Both the utterance and the identification of vowel depend upon the language and dialectal back grounds and the vocal and auditory characteristics the individuals concerned. The plan of the study calibration of recording and measuring equipment an methods for checking the performance of bot speakers and listeners are described. The method are illustrated from results of tests involving some 7 speakers and 70 listeners.

534.83

3408. Design characteristics for noise control of j engine test cells. H. C. Hardy. *J. Acoust. Soc. Amer.*, **24**, 185–90 (*March*, 1952).

An arbitrary design goal was set from a previou survey of city noise. With the expected octave ban levels at a distance of 3 000 ft, for 10 jet engines wit afterburners the quieting necessary is 50 and 55 d respectively, in the 150–300 and the 300–600 c bands, these two bands being the most difficult t control. An analysis of the required volume an dependent cost of the structure is given as the functio of the amount of quieting needed, the quantity heated gases exhausted, the temperature of the gase and the velocity of flow permitted. Two unco ventional but economical systems of noise contro (1) a series of acoustically treated plenums, an (2) a series of acoustical lined 180-degree turns, a recommended. Design equations and confirmi data from model studies are presented.

534.8

3409. The acoustic properties of flying helmet D. R. Wilkie. *J. Acoust. Soc. Amer.*, **24**, 191- (*March*, 1952).

A convenient and theoretically satisfactory metho for measuring the sound attenuation of flying helme is described in which a miniature microphone is em ployed to measure the sound intensity inside th helmet capsule. A theory of sound transmissio through helmet capsules is proposed, the validity which is established by a direct comparison of the retical with experimental results It is thus possib to design helmets which are considerably better tha standard types. Comparison tests on one su helmet are described.

534.8

3410. The noise field of a turbo-jet engine. H. von Gierke, H. O. Parrack, W. J. Gannon an R. G. Hansen. *J. Acoust. Soc. Amer.*, **24**, 169- (*March*, 1952).

The noise fields generated by a standard turbo- aircraft engine have been measured for three differe power settings. Measurements were made at poi on circles around the engine having radii of 25 a 50 ft. For the 50 ft distance the directional char teristic is presented for the over-all sound pressure a for the noise in the different octave bands starting 37·5 c/s. From these measurements the total acous power radiated from the engine is calculated to approximately 69 kW at full engine power. The d tribution of this power over the different frequer

ands and space angles is shown. The highest total nergy per cycle and the highest sound levels are ound at frequencies near 100 c/s for the higher power ttings of the engine. Above that frequency range ie total energy per cycle drops approximately as the ciprocal of the square of the frequency. A.

534.839

411. Noise intensity equation in building and its olution. H. SATO. *Mem. Fac. Techn. Tokyo Metrop. Univ., No.* 1, 16–20 (1951).

An approximate theoretical method for obtaining ie noise intensity in any room of a building contain- ig several noise sources. G. F. HODSMAN

534.844

412. An inexpensive acoustic treatment for gym- asiums, civic coliseums, and similar structures. . N. LANE, F. SEAY AND C. P. BONER. *J. Acoust. Soc. mer.*, **24,** 127–8 (*March*, 1952).

The acoustic treatment of an excessively rever- erant civic coliseum is described. Before treatment he structure, originally an aircraft hangar, had a harply peaked reverberation time of eight seconds in he region between 600 and 800 c/s. Thirty-two housand square feet of two-inch-thick Fiberglas anels were suspended in horizontal V's six feet elow the parabolic metal ceiling. After treatment, he reverberation time is essentially uniform from 00 c/s to 8 000 c/s, with an average value of approxi- nately 1·2 sec. The method of construction and he mounting of the panels is described. Sound bsorption coefficients for these panels are given, and comparison is made between the value obtained rom the coliseum installation and the value obtained or 72 square feet of identical panel hung in the Defence Research Laboratory polycylindrical rever- eration chamber. A.

534.845

413. Total sound absorption for upholstered heater chairs with audience. R. N. LANE AND J. BOTSFORD. *J. Acoust. Soc. Amer.*, **24,** 125–6 (*March*, 952).

The total absorption for theatre chairs with back nd seats upholstered in mohair has been measured rom 250 to 9 000 c/s. Values are given for the chairs vith (1) seats up, (2) seats down and (3) occupied by dults. A.

534.846

414. The acoustics of ancient theatres. F. CANAC. *Rev. Sci.* [*Paris*] **89,** 151–66 (*May–June*, 1951) *In French.*

The principles on which ancient Greek and Roman heatres were constructed are discussed and several hotographs are included. Results are given of tests t the Orange and Vaison theatres which show that hey had been designed to achieve satisfactory acoustic roperties. It is pointed out that the devices used to einforce sound and eliminate echoes and external ounds are similar in principle to those used to-day. G. F. HODSMAN

534.846

415. Comparative auditorium measurements of the bsorption coefficients of sound absorbing materials. . VENZKE. *Tech. Hausmitt. NordwDtsch. Rdfunks*, , 1–3 (*Jan.–Feb.*, 1952) *In German.*

The test material used in the comparative measure- ments was known as Hallorit (a compressed mineral- wool 3 cm thick). Curves are shown of the experi- mental results obtained in 8 different auditoria (vary- ing in volume from 50 to 166 m³) over a range of frequencies from 100 c/s to 4 000 c/s using an area of 15 m² of absorbent surface. In all cases the curves of absorption as a function of frequency are similar, but the values calculated from Sabine's formula are higher than those obtained experimentally in a Knudsen tube or by calculation from the theory of Morse and Bolt. A. B. WOOD

534.85

3416. Phonograph needle drag distortion. J. RABINOW AND E. CODIER. *J. Acoust. Soc. Amer.*, **24,** 216–25 (*March*, 1952).

Graphical synthesis led to the belief that the tangential motion of the needle would cause dis- tortion of the output signal. In a common type of crystal pick-up, equipped with the usual steel needle, tangential motion of the stylus tip does occur as postulated, ranging in amplitude up to 0·0012″, the amplitude of the motion being a function of the recorded frequency, the amplitude, the radius of the groove, recording speed, record and needle wear, and needle pressure. In addition to this tangential motion, a vertical resonance occurring in the needle- pick-up arm system causes tangential motions of the needle tip (freq. 24 c/s) with amplitudes of up to 0·0015″. Attempts to detect the distortion of the output signal were unsuccessful principally because of the presence of other distortions which masked the tangential motion distortion. However, since the existence of tangential motions and their amplitudes were established, it became possible to compute the cross-modulation products caused. A.

534.861.1

3417. Helmholtz resonators in the acoustic treatment of broadcasting studios. C. L. S. GILFORD. *Brit. J. Appl. Phys.*, **3,** 86–72 (*March*, 1952).

A theory of the action of Helmholtz resonators as sound absorbers is presented, covering both the isolated resonator and regular arrays. Experiments in reverberation rooms and acoustically treated studios are described and general recommendations for design are given. Regular arrays are preferable to single resonators, openings being made more resistive by covering with a fabric It is concluded that great variations in design to suit architectural requirements may be made without loss of effective- ness, and the widths of the frequency band over which absorption takes place may be varied between wide limits. A.

OPTICS . RADIATION . SPECTRA 535

535.22

3418. Some recent determinations of the velocity of light. J. F. MULLIGAN. *Amer. J. Phys.*, **20,** 165–72 (*March*, 1952).

A number of important measurements of the velocity of light have been made in recent years. Four of these determinations are here outlined, with

emphasis on the experimental techniques used. These include the work of Essen, and of Hansen and Bol, with microwave cavity resonators, Bergstrand's measurements with a modified Kerr-cell technique, and Aslakson's "Shoran" measurements. It is pointed out that these four determinations are consistent among themselves and yield a value very close to 299 790 km/sec for the velocity of light in vacuum. This is completely outside the probable error of the value 299 776 ± 4 km/sec generally accepted by physicists in the years 1934–49 on the basis of rotating mirror and Kerr-cell measurements. Some possible reasons for this discepancy are discussed. A.

535.223

3419. A new determination of the velocity of electromagnetic radiation by microwave interferometry. K. D. Froome. Letter in *Nature* [*Lond.*] **169**, 107–8 (*Jan.* 19, 1952).

The free-space velocity of waves of length 1·25 cm is measured by means of a two-beam interferometer, one beam being confined in a waveguide and the other being reflected from a metal plate in a large room at a distance of up to 21·5 m from the transmitting horn. The length of this path is altered through an integral number of wavelengths by means of accurately calibrated end-gauges. Corrections are made for diffraction effects and for the refractive index of the atmosphere to give the result $c_0 = 299\,792{\cdot}6 \pm 0{\cdot}7$ km/s, which is in close agreement with other recent values [see Abstr. 4219 (1951)]. L. ESSEN

535.231.4

3420. Some measurements of the total emissivity of metals and pure refractory oxides and the variation of emissivity with temperature. A. H. Sully, E. A. Brandes and R. B. Waterhouse. *Brit. J. Appl. Phys.*, **3**, 97–101 (*March*, 1952).

A method has been described for the rapid determination of the total emissivity of metals and oxides in the temperature range 300–800°c. Values have been obtained for lampblack and polished platinum and also for Nimonic 75, pure nickel and stainless steel, with various surface conditions. The total emissivities of the pure oxides ceria, zirconia, thoria, magnesia, alumina and fused silica have also been determined. The effect of particle size of the oxides and the variation of emissivity with angle of emission have been studied. A.

535.24

3421. Studies in heterochromatic photometry by the international exchange of coloured glasses. J. Terrien. *Rev. Opt.* (*Théor. Instrum.*) **30**, 415–21 (*Oct.*, 1951) *In French.*

Sets of 4 coloured glasses, neutral, green, blue and red, were prepared for an international comparison of different methods of heterochromatic photometry, initiated by the Commission Int. de l'Eclairage and carried out by the Bureau Int. des Poids et Mesures. The glasses in each set were closely the same in spectral transmission and the sets were distributed to the national laboratories of Germany, U.S.A., France, Gt. Britain, Holland, Italy, Japan and U.S.S.R. At each laboratory the spectral transmission curves were determined and the overall transmission for light of colour temperature 2 700°K was found (*a*) by calculation from the spectrophotometric values, (*b*) by the flicker method under standard conditions, (*c*) in some laboratories by the use of a photocell and filter. The results show, on the whole, good agreement in spectrophotometry and in photoelectric photometry. The discrepancies by the flicker method are so large that it is considered undesirable to use this method in the photometry of light of high or moderate saturation. J. W. T. WALSH

535.24 : 535.8

3422. A specifiable logarithmic high aperture iris with 15 000 : 1 modulation. C. A. Morrison. *J. Opt. Soc. Amer.*, **42**, 90–3 (*Feb.*, 1952).

A high-aperture iris modulator covering a range of 15 000 : 1, suitable for photometers, densitometers etc., and reproducible for all practical purposes to specification without empirical calibration is described. A

535.24 : 621.327.43

3423. Photometric measurements. R. Deaglio and C. M. Garelli. *R.C.* 51 *Riun. Ass. Elettrotec. Ital.* 1950, *Fasc.* 2, 195–6 (*Paper* 134, 1951) *In Italian.*

The particular problems discussed are: (*a*) the measurement of the luminous flux from fluorescent lamps, (*b*) the specification of their colour by means of 8 spectral wave-bands, (*c*) the determination of the spectral transmission curves of colour filters circulated among the national laboratories and the study of other methods of determining their transmission factors. J. W. T. WALSH (R

535.24

3424. The fundamental character of the photometric system. G. L. Walls. *Amer. J. Phys.*, **20**, 145–51 (*March*, 1952).

It is shown that photometric quantities and units are not psychophysical entities, as officially claimed, since they express no relationships between subjective intensity (brightness) and the true visual stimulus magnitudes (which are energy magnitudes). It is shown that no theoretical barriers exist to the determination of that fraction of one watt at λ555 mμ which provides one lumen of luminous flux (photometric "light"). It is further shown that this value will equal an absolute number of quanta/sec usefully absorbed in photochemical molecules in the standard observer in a standard state of adaptation, that this number of quanta/sec will be independent of wavelength if the brightness-generating receptors are all alike, and that it will vary with wavelength for purely objective reasons if each colour receptor type makes a specific contribution to brightness. It is concluded that since the lumen is expressible as an absolute number of quanta/sec, there is no intrinsic subjective element in the photometric system and the system is not psychophysical but "100% physical." A

535.247 : 522.615 : 621.317.39 : 621.38

Developments in the practical use of photocells for measuring faint light. *See Abstr.* 3209

535.247

3425. General purpose photoelectric telephotometer. P. D. Carman. Letter in *J. Opt. Soc. Amer.*, **42**, 14 (*Feb.*, 1952).

Describes an experimental photoelectric telephotometer for the measurement of luminance

rightness). A photomultiplier cell is used with a lour sensitivity correction filter and the range is tended with four neutral filters. Full-scale deflection the microammeter is obtained with a luminance of 5 ft-L; drift is slow and "noise" small.

J. W. T. WALSH

535.31

26. Fourier treatment of optical processes. ELIAS, D. S. GREY AND D. Z. ROBINSON. *J. Opt. c. Amer.*, **42**, 127–34 (*Feb.*, 1952).

Many optical processes of image formation, image ansfer and image analysis may be represented as ne, or a succession of several, linear operations. A near operation upon a flux distribution function of *n*-dimensional argument is defined as one which places the value of the function at a point by a near, weighted average taken over a neighbourhood that point. While such an operation is completely termined by the weighting function used, it is also termined by a "wave-number" spectrum which is function of an *n*-dimensional wave-number vector. his wave-number spectrum is the complex conjugate the *n*-dimensional Fourier transform of the weight-g function. The wave-number spectrum of the ux distribution modified by any number of successive near operations is the product of the wave-number ectrum of the original distribution, and the wave-mber spectra of the several linear operations. An alysis thus performed in wave-number space places successive integrations by successive multi-ications. This method of analysis is an extension of e usual method of treating filters in electronic rcuits, and may be used to solve problems analogous those treated in circuit theory. These are: (1) to aluate the performance of a system; (2) to design a ocess to search an image for a configuration; (3) to produce a picture, with discrimination in favour of configuration desired, and against others; and (4) to ualize a picture, i.e. to remove image degradation.

A.

535.315 : 535.375.5

27. The optical properties of a compound liquid ism suitable for studies of the Raman effect. H. J. V. YRRELL AND G. K. T. CONN. *J. Opt. Soc. Amer.*, , 106–13 (*Feb.*, 1952).

Provided that the difficulties associated with the gh temperature-coefficient of refractive index of the quid component can be overcome, there appear to certain advantages in the use of compound liquid-ass prisms (Zenger or Wernicke type), in Raman ectrographs. In particular, the curvature of the slit nage is negligible, an important factor if photo-ectric recording is used. The theoretical equations r dispersion, resolving power and image curvature r such systems have been derived. A small Littrow-ounted Zenger prism has been constructed, and a lution of mercuric bromide in aqueous barium omide solution chosen as the liquid component ter studying its optical constants. Without using aborate thermostatic control, satisfactory spectro-ams of the iron arc have been obtained. The actical resolution in the relatively crude experiments 500 in the wavelength range $\lambda = 4\,200$–$5\,000$ Å) is limited by the slit width used, and the reciprocal dispersion in the neighbourhood of $\lambda = 4\,400$ Å was found to be 25 Å/mm. No appreciable curvature of the slit image was observed with a slit height of 2·5 cm.

A.

535.323

3428. The refractive index of quartz (ordinary index) from 5–14 μ. J. RAMADIER-DELBÈS. Letter in *J. Phys. Radium*, **12**, 954 (*Dec.*, 1951) *In French.*

The refractive index is found from the channel interference spectrum, obtained by placing a thin film of the quartz before a spectrograph. The values agree with those of Simon, obtained by a reflection method.

R. W. FISH

535.323

3429. A comparison of the physical properties of cesium bromide and thallium bromide-iodide. S. S. BALLARD, L. S. COMBES AND K. A. MCCARTHY. Letter in *J. Opt. Soc. Amer.*, **42**, 65–6 (*Jan.*, 1952).

Both materials, now available as synthetic crystals, are transparent to 40 μ and are useful for prism spectrometers. Some physical properties and constants for both materials are given.

R. W. FISH

535.324

3430. The refractive index of carbon tetrachloride from 5 to 15 μ. J. RAMADIER-DELBÈS. Letter in *J. Phys. Radium*, **13**, 47 (*Jan.*, 1952) *In French.*

The refractive index has been derived from measurements made on interference channel-spectra using a thin film of liquid. The results reveal anomalous dispersion in the neighbourhood of the 800 cm^{-1} absorption band. The refractive index curve runs rapidly down to 1·0 near a wavelength slightly above 12 μ.

S. TOLANSKY

535.33.03

3431. Radiant energy in different wavelength regions for condensed discharges in xenon. R. LEGROS. *C.R. Acad. Sci.* [*Paris*] **234**, 718–20 (*Feb.* 11, 1952) *In French.*

Measurements are made of the relative spectral emission intensities from xenon in a flash discharge tube with variation of gas pressure tube potential and discharge current. U.v. and visible emissions decrease as the pressure is increased while i.r. emission increases. Low-voltage, high-capacity discharges are also favourable to the latter emission.

G. F. J. GARLICK

535.33.03 : 531.552 : 536.46

3432. Phenomena associated with the flight of ultra-speed pellets. II. Spectral character of luminosity. W. C. WHITE, J. S. RINEHART AND W. A. ALLEN. *J. Appl. Phys.*, **23**, 198–201 (*Feb.*, 1952).

For Pt I, see Abstr. 2439 (1952). The spectroscopic character of the luminous trails generated by ultra-speed pellets has been investigated. A total of 7 spectrograms have been measured and reduced. Three of these were of 5·0 km/sec Al pellets; two were of 5·9 km/sec Mg pellets; one was of a 6·0 km/sec Mg–Li–Al pellet; and one was of a Ti pellet whose velocity was estimated at about 4·5 km/sec. The pronounced features of the spectrograms are: AlO bands in the Al spectra, Mg lines and MgO bands at the Mg spectra, strong Li lines and a pronounced continuum in the Mg–Li–Al spectra, and TiO bands

in the Ti spectra. Other features of the spectra are: prominent Al I lines at λλ3944 and 3961 and a relatively weak continuum in the Al spectra, a stronger continuum in the Mg spectra, and relatively weak MgO bands in the Mg–Li spectra. The time-resolved spectra show that the AlO persists in the excited state twice as long as the Al. The Al oxidizes almost completely, leaving AlO in an excited state which continues to emit light after the Al is burned. A.

535.33.07

3433. An ordinate printing attachment for the G.E. recording spectrophotometer. O. E. MILLER. Letter in *J. Opt. Soc. Amer.*, **41**, 1060–1 (*Dec.*, 1951).

Actual figures of transmittance or density are printed automatically, eliminating the time and error of reading these from a curve. G. F. LOTHIAN

535.33.07–15

3434. A twelve-inch far infrared grating spectrometer. T. K. MCCUBBIN, JR AND W. M. SINTON. *J. Opt. Soc. Amer.*, **42**, 113–15 (*Feb.*, 1952).

A grating spectrometer capable of a spectral resolution of from one to two wave-numbers in the region from 100 to 700 microns is described. Sources of far infrared radiation and techniques for the separation of overlapping spectral orders are discussed. A.

535.33.07–15 : 537.312.5

Photoconductive cells for detection of infrared radiation. *See Abstr.* 2715

535.33.07–32

3435. Photometric and photoenergetic measurements in the ultraviolet at the Institut d'Optique. F. DESVIGNES. *Rev. Opt.* (*Théor. Instrum.*) **31**, 87–97 (*Feb.* 1, 1952).

Description of the apparatus used for spectrophotometric and spectroradiometric research in the ultraviolet, including light sources, monochromator and receivers. Methods used for the study of transmitting or reflecting materials, and of sources and receivers; necessary precautions; precision attained; examples of results obtained for sources. A.

535.331 : 537.228.5

3436. Application of the method of polynomials to the theory of the Stark effect. F. I. VISHNEVSKIĬ. Letter in *Zh. Eksper. Teor. Fiz.*, **21**, 946–7 (*No.* 8, 1951) *In Russian.*

535.338.3

3437. Certain forbidden spectral lines of cadmium. J. R. HOLMES AND F. DELOUME. *J. Opt. Soc. Amer.*, **42**, 77–9 (*Feb.*, 1952).

An experimental investigation was made to establish conclusively the source and nature of the highly forbidden lines 3 320 Å × ($5^1S_0 - 5^3P_0^0$), 3 141 Å ($5^1S_0 - 5^3P_2^0$) and 3 403·1 Å ($5^3P_1^0 - 5^3D_3$) in cadmium. All such transitions are strictly forbidden for electric dipole radiation and by most of the selection rules for higher pole and magnetic dipole radiation. Bowen and others have suggested that the lines are emitted as the result of the interaction of the optical electron with the magnetic moment of the nucleus and are, therefore, produced by only the odd weighted isotopes. The intensities of the above-mentioned lines as emitted by a cadmium sample which had been enriched in one of the odd isotopes were compared with the intensities of the same lines emitted by a sample of natural cadmium. Within the experimental error it was found that the forbidden lines are emitted with an intensity proportional to the odd isotope abundance and, therefore, it seems conclusively established that they arise only from the odd isotopes. Comparison of the intensities of some of the forbidden lines with the intensity of an allowed transition from the same multiplet was made in order to give a measure of the interaction of the optical electron with the nuclear magnetic moment. A.

535.338.3

3438. Emission and absorption of radiation by spectral lines with Doppler contour. S. S. PENNER. *J. Chem. Phys.*, **20**, 507–10 (*March*, 1952).

Equations are developed for observable intensities in emission and absorption for spectral lines with Doppler contour. It is shown that the theoretical relations which are usually employed in estimating effective temperatures of internal energy states (*a*) require slight modifications when proper allowance is made for the shape of spectral lines, and (*b*) are not valid unless the product of spectral absorption coefficient and optical density is sufficiently small. Illustrative calculations on several spectral lines belonging to the (0, 0) band of the $^2\Sigma \rightarrow {}^2\Pi$ band system of OH suggest that the conditions under which the basic relations hold are probably not satisfied for representative combustion flames. A.

535.338.3

3439. Experiments on production of auroral radiation. N. D. SAYERS AND K. G. EMELÉUS. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 219–26 (*March*, 1952).

Further experiments have been made on the production in the laboratory of the "forbidden" red and green auroral lines, and the ultraviolet transauroral line of OI. The mean concentration of oxygen atoms in the 1^1S_0 and 5^5D states in the columns has been found from absolute intensity measurements. The decay of the green radiation produced by a Tesla discharge through a high-pressure source has been investigated with a photo-multiplier tube. It occurs at approximately the rate to be expected if the atoms in the ^1S state are undergoing spontaneous transitions to lower atomic levels, but complicating factors make it difficult to deduce transition probabilities from the experiment. A.

535.338.3

3440. Absolute *f*-values for lines of Cr I and Mn I. L. HULDT AND A. LAGERQVIST. Letter in *J. Opt. Soc. Amer.*, **42**, 142 (*Feb.*, 1952).

Absolute *f*-values for 6 lines of Cr and 3 of Mn are obtained from equilibria between metal, metal oxide and atomic O in C_2H_2 flame. The previously determined dissociation energies of CrO and MnO are used. A. G. GAYDON

535.338.33

3441. Anomalous hyperfine structure in the spectrum of Al II. S. SUWA. *J. Phys. Soc. Japan*, **6**, 231–[illegible] (*July–Aug.*, 1951).

A Lummer plate and a Fabry–Pérot interferometer were used for the study of the h.f.s. of the 4^3P–5^3[illegible]

e of Al II (for which the triplet separation is of the ne order as the h.f.s., but the singlet-triplet separa- n is much larger) and of the $4^1, {}^3F$–nG series for ich also the latter separation is small. From results l application of the Goudsmit–Fermi–Segrè theory, magnetic moment of Al^{27} results $3{\cdot}62 \pm 0{\cdot}01$ n.m. agreement with values obtained with the magnetic onance method. L. PINCHERLE

535.338.332

42. Hyperfine structure and isotope shift in the ctrum of tellurium. J. S. ROSS AND K. MURAKAWA. *vs. Rev.*, **85**, 859–63 (*Feb.* 5, 1952).

Using separated isotopes of tellurium, the hyperfine ucture of the Te I and Te II spectra was studied. e magnetic moments of the two odd isotopes re calculated to be $\mu(Te^{125}) = -0{\cdot}6 \pm 0{\cdot}2$ nm, $Te^{123}) = -0{\cdot}5 \pm 0{\cdot}2$ nm. The ratio of the gnetic moments was determined to be $\mu^{125}/\mu^{123} = 186 \pm 0{\cdot}007$. Anomalous shift of the even topes was detected in the lines $\lambda 4006$ $[5s5p^4\ {}^4P_{5/2} - {}^3(^3P_0)6p_{3/2}]$ and $\lambda 4049$ $(5s5p^4\ {}^4P_{3/2} - [5p^2(^3P_1)6p]_{3/2})$. e spacings between consecutive even isotopes in e line $\lambda 4006$ were as follows: $\Delta(130 - 128) = 0{\cdot}014$, $128 - 126) = 0{\cdot}011$, $\Delta(126 - 124) = 0{\cdot}026$, $124 - 122) = 0{\cdot}017$, $\Delta(122 - 120) = 0{\cdot}017$ cm^{-1}, e component due to the heaviest isotope lying on e largest frequency side. The centres of gravity of e odd isotopes in the line $\lambda 4006$ were: $\Delta(124 - 5) = 0{\cdot}002$, $\Delta(123 - 122) = 0{\cdot}000$ cm^{-1}. $\lambda 4049$ owed nearly the same isotope effect as $\lambda 4006$. A.

535.338.332

43. Hyperfine structure in the spectrum of erbium. MURAKAWA AND S. SUWA. Letter in *Phys. Rev.*, , 683 (*Feb.* 15, 1952).

More than twenty lines were found to possess a easurable isotope shift. $(170 - 168) : (168 - 6) : (166 - 164) = 1 : 0{\cdot}92 \pm 0{\cdot}05 : 0{\cdot}88 \pm 0{\cdot}07$. e shift for one 6*s*-electron fits reasonably well with e shifts per one 6*s*-electron per addition of two utrons in other heavy neutral atoms. L. PINCHERLE

535.338.333

44. On the isotope shift in the Pd I spectrum and e nuclear moments of Pd 105. P. BRIX AND A. EUDEL. Note in *Naturwissenschaften*, **38**, 431–2 *o.* 18, 1951) *In German.*

The shift has the sign of the nuclear volume effect: e Pd 105 nuclear angular momentum quantum mber I, determined from intensity measurements, $> \frac{1}{2}$, probably $I = 5/2$. J. JACOBS

535.338.333

45. Effect of intrinsic moment of electron on ectroscopic isotope shift. G. BREIT AND W. W. ENDENIN. Letter in *Phys. Rev.*, **85**, 689 (*Feb.* 15, 52).

A calculation of the ratio R between the 1st-order ect of the intrinsic magnetic moment μ_e on the ergy of an *s*-electron and the effect caused by the iteness of the nucleus gave the result $R = -0{\cdot}50$ Pb^{208}, taking $\mu_e \simeq -\alpha e\hbar/4\pi mc$. L. PINCHERLE

535.338.333

46. Atomic spectroscopy and separated isotopes. R. MCNALLY, JR. *Amer. J. Phys.*, **20**, 152–60 *Iarch*, 1952).

The advantages in the use of separated isotopes in atomic spectroscopy for the determination of nuclear moments I, μ, Q, and for studies of the isotope-shift phenomena are discussed. Illustrations of spectra are given for Hg, U and Sm. In addition, a summary is given of twenty-two so-called problem nuclei, i.e. those naturally occurring isotopes for which the nuclear moments are completely uncertain. Concluding remarks are made on such problems as the evaluation of the absolute magnitude of isotope shifts, the role of "forbidden transitions" in isotope spectra, and the potential future value of spectro-isotopic assay techniques. A.

535.338.4

3447. A new band system of the NO molecule. P. BAER AND E. MIESCHER. *Helv. Phys. Acta*, **24**, 331–3 (*No.* 4, 1951) *In German.*

The system, $B' - X^2\Pi$, is obtained in a discharge through a mixture of He and NO. The constants, in cm^{-1}, for B' are: $\nu_e = 60\,366$, $\omega_e = 1\,216$, $x_e\omega_e = 16{\cdot}4$. The bands show a doublet splitting of 121 cm^{-1}. R. F. BARROW

535.338.4

3448. Band spectrum of praseodymium oxide. A. GATTERER AND S. G. KRISHNAMURTY. Letter in *J. Opt. Soc. Amer.*, **42**, 143 (*Feb.*, 1952).

Three systems have been identified in the flame of a heavy-current arc. Vibrational analysis of a system $C^2\Pi - X^2\Sigma$ leads to $\omega_3'' \sim 873$ cm^{-1}. R. F. BARROW

535.338.4 : 523.57

3449. Laboratory studies of the λ4050 group of cometary spectra. A. E. DOUGLAS. *Astrophys. J.*, **114**, 466–8 (*Nov.*, 1951).

The group of bands occurring in the spectra of comets near 4 050 Å has been produced in the laboratory and photographed under high resolution. By using deuterium in the source, it has been verified that the molecule emitting the bands does not contain H; by using the C^{13} isotope, it has been indicated that the emitter does contain more than one C atom. Although the exact composition of the emitting molecule has not been unambiguously determined, evidence from the fine structure of the 4 050 Å band and the isotope effect indicate that it may be a linear triatomic carbon molecule, C_3. A.

535.338.4 : 551.594.5

3450. The analysis of auroral emission bands from the $A^2\Pi$ state of N_2^+. A. B. MEINEL. *Astrophys. J.*, **114**, 431–7 (*Nov.*, 1951).

A study of the derived molecular constants, possible constituents, band profiles, relative band intensities and isoelectronic sequence correlations leads to the conclusion that the strong unidentified infrared auroral emission bands arise from the long-missing $A^2\Pi$ level of the N_2^+ molecule. A.

535.338.4

3451. The emission of radiation from diatomic gases. III. Numerical emissivity calculations for carbon monoxide for low optical densities at 300°K and atmospheric pressure. S. S. PENNER, M. H. OSTRANDER AND H. S. TSIEN. *J. Appl. Phys.*, **23**, 256–63 (*Feb.*, 1952).

For Pt II, see Abstr. 9382 (1951). Numerical emissivity calculations at 300°K and atmospheric pressure for non-overlapping rotational lines have

been carried out for CO using a dispersion formula for the line-shape representation. Use of the best available experimental data on integrated absorption and rotational line-width leads to calculated emissivities which are in excellent agreement with extrapolated empirical data published by Hottel and Ullrich. In particular, the theoretical dependence of emissivity on optical density, for small optical densities at 300°K, has been shown to follow experimental observations with satisfactory precision. For small optical densities the calculated emissivity is found to be proportional to the square root of the assumed rotational line-width, thus emphasizing the need for accurate line-width determinations at elevated temperatures. The limits of validity of the treatment utilizing non-overlapping rotational lines are defined by examining overlapping between adjacent weak and strong rotational lines. The calculation of emissivities can be simplified by the use of approximate treatments. Thus absolute values of the emissivity can be predicted within 10% by utilizing a treatment for non-overlapping, equally spaced and equally intense lines, together with empirically determined values for the equivalent mean integrated absorption of the rotational lines of CO. A better analytic solution, which does not involve the assumptions of equal spacing and equal intensity of the rotational lines, has been obtained by utilizing asymptotic relations for large values of modified Bessel functions. A.

535.338.4

3452. Spectroscopic studies of low pressure combustion flames. S. S. PENNER, M. GILBERT AND D. WEBER. Letter in *J. Chem. Phys.*, **20**, 522–3 (*March*, 1952).

A rectangular burner and the optical system are described. Preliminary measurements of OH rotational temperature in propane/O_2 agree with Gaydon and Wolfhard's, but anomalies may be due to invalid interpretation of experimental data. A. G. GAYDON

535.339

3453. Multiple monochromators. I. Design of multiple monochromators. A. WALSH. *J. Opt. Soc. Amer.*, **42**, 94–5 (*Feb.*, 1952).

A description is given of a simple method for converting a conventional monochromator to a double or multiple monochromator having much higher resolving power and giving almost complete elimination of scattered radiation. To construct a double monochromator, radiation which normally passes through the exit slit is reflected back through the dispersing system by a pair of mirrors at right angles to each other, and finally passes through the exit slit. A chopper is arranged to interrupt the radiation reflected from these mirrors, and the signal from the detector is amplified by an amplifier tuned to the same frequency as the chopper. Thus only that radiation which has passed twice through the dispersing system produces an output signal. The factors governing the design of multiple monochromators are discussed. A.

535.339

3454. Multiple monochromators. II. Application of a double monochromator to infrared spectroscopy. A. WALSH. *J. Opt. Soc. Amer.*, **42**, 96–100 (*Feb.* 1952).

The factors governing the performance of infrared spectrometers are discussed, and it is shown that the use of multiple monochromators of the type described in the preceding paper provides one of the best methods of obtaining high resolution infrared spectra. The conversion of a small prism infrared spectrometer to a double monochromator is described. The performance of the instrument is illustrated by reproductions of typical spectra, and it is shown that the resolution approaches that of the best grating instruments. Scattered radiation is so small as to be negligible. A

535.343 : 535.372 : 548.

3455. Electron and vibration levels of the benzene molecule and crystal. V. L. BROUDE, B. S. MEDVEDEV AND A. F. PRIKHOTKO. *Zh. Eksper. Teor. Fiz.* **21**, 665–72 (*No.* 6, 1951) *In Russian.*

A comparison of the absorption and fluorescence spectra of a crystal with vapour spectra, and with absorption spectra of benzene in alcohol and dioxane. In the crystal were found molecular states corresponding to the gas-phase ones, as well as pure crystalline states, giving a double series of strongly polarized lines. A correlation with the weakly polarized series leads to information about the direction of scattering of light vibration in the crystal relative to the crystal axes. J. JACOB

535.343–1

3456. On the shape of radio-frequency spectrum S. SUEOKA. Note in *J. Phys. Soc. Japan*, **6**, 281– (*July–Aug.*, 1951).

The shape of the radiofrequency absorption line o a diatomic molecule for a $m_I \rightarrow m_I - 1$ transitio and fixed J is obtained by summation over m_J allowin for the natural breadth and quadrupole coupling In certain cases the peak is not at the resonanc frequency. D. H. WHIFFE

535.343.1–14 : 539.13

3457. The microwave spectra and dipole moment o stable pentaborane. H. J. HROSTOWSKI, R. J. MYER AND G. C. PIMENTEL. Letter in *J. Chem. Phys.*, 2 518 (*March*, 1952).

Microwave spectrum of B_5H_9 near 28 000 Mc/s wit B^{10} and B^{11} isotopes is consistent with the $J_{1\rightarrow 2}$ trans tion of a molecule with C_{4v} symmetry. B–B (rin ring) 1·80 ± 0·01 Å and B–B (ring-apex) 1·69 ± 0·02 Å. Dipole moment 2·13 ± 0·04 D. D. H. WHIFFE

535.343.

3458. Comparison of absorption spectrum o uranium tetrachloride with that of praseodymium tr chloride and of uranium trichloride with that of ne dymium trichloride. K. M. SANCIER AND S. FREE *J. Chem. Phys.*, **20**, 349–51 (*March*, 1952).

The absorption spectra of the following substance were taken at 77°K: crystals of anhydrous UC $PrCl_3$, UCl_3, $NdCl_3$, UF_4 and a solution of UCl_4 in solvent consisting of propyl alcohol, propene an propane. The spectra of the "iso-electronic" ion U^{+4} and Pr^{+3} exhibited a match in wave-number o the centres of gravity of the separate absorptio

roups. The correspondences between U^{+4} and r^{+3} lead to term assignments for the basic and ctivated electronic states of U^{+4} since those of Pr^{+3} re known. Thus, the two least stable electrons of J^{+4} in the basic state and to a good approximation a the excited states lies within the 5*f* shell. The inter-ction of the fields of the environment of the ions in ne case of U^{+4} is greater than in the case of Pr^{+3} and especially marked in their $^1I_6$ states. The correla-on of the spectra of U^{+3} and Nd^{+3} is less distinct. A new method has been developed for obtaining the bsorption spectra of very small anisotropic crystals.

A.

535.343.2 : 539.132

459. The theory of the absorption of light by rystalline benzene. A. S. DAVYDOV. *Zh. Eksper. Teor. Fiz.*, **21**, 673–6 (*No.* 6, 1951) *In Russian.*

It is shown that by examining the absorption pectrum of polarized light it is possible to establish he symmetry of the electronic transitions in the mole-ule of benzene.

A. L. MACKAY

535.343.2–15

460. Polarized infrared spectrum of sodium nitrite. R. NEWMAN. *J. Chem. Phys.*, **20**, 444–6 (*March*, 952).

The infrared spectra of single crystals of $NaNO_2$ vere obtained in polarized light. The polarization ehaviour of the strong absorptions leads to the ollowing assignment of the nitrite fundamentals $\nu_1 = 1\,325\ cm^{-1}$, $\nu_2 = 831\ cm^{-1}$ and $\nu_3 = 1\,360$ m^{-1}. Other bands of lower intensity are observed. A combination band ($\nu_1 + \nu_3$) at 2 670 cm^{-1} shows a olarization behaviour in accord with site group election rules. An effect is discussed which results rom the use of an infrared microscope in the investi-ation of polarization spectra.

A.

535.343.32–15

461. Infra-red studies of solvent effects. N. S. HAM, A. L. G. REES AND A. WALSH. Letter in *Nature Lond.*] **169**, 110–11 (*Jan.* 19, 1952).

From the vibrational absorption spectra of saturated olutions of iodine in (*a*) a benzene-CCl_4 mixture, *b*) ether, (*c*) pyridine in the range 2·5–25 μ at room emperature, the formation of a solute-solvent com-plex is indicated in (*c*) but not in (*a*) and (*b*).

W. R. ANGUS

535.343.32–15

462. Near infra-red absorption by solutions of in-rganic substances. S. D. CHATTERJEE, N. N. GHOSH ND A. M. NAHA. Letter in *J. Chem. Phys.*, **20**, 344–5 *Feb.*, 1952).

The total transmission from 0·8–1·1 μ of solutions re measured with a CsO photoemissive cathode and "Kodak" infrared filter. Preliminary results for Ni and Cu salts and complexes are given.

D. H. WHIFFEN

535.343.32–32

463. The short wavelength bands of the V^{3+} com-plexes. H. HARTMANN. Letter in *Z. Naturforsch.*, **5a**, 781 (*Dec.*, 1951) *In German.*

The difference of the u.v. absorption spectra of $V(H_2O)_6]^{3+}$ and $[V(alcohol)_6]^{3+}$ yields an energy equal to the ionization energy difference of water and alcohol : 1·9 eV.

C. TURNER

535.343.4–14

3464. Beam system for reduction of Doppler broadening of a microwave absorption line. H. R. JOHNSON AND M. W. P. STRANDBERG. Letter in *Phys. Rev.*, **85**, 503–4 (*Feb.* 1, 1952).

By confining NH_3 molecules to a beam the Doppler breadth of the (3,3) absorption line viewed transversely was reduced from 36 to 20 kc/s. Experimental details are given.

D. H. WHIFFEN

535.343.4–14

3465. The microwave spectrum of CF_3SF_5. P. KISLIUK AND G. A. SILVEY. *J. Chem. Phys.*, **20**, 517 (*March*, 1952).

The pure rotational spectrum of CF_3SF_5 has been observed in the microwave region. It is confirmed that the structure is almost certainly trifluoromethyl sulphurpentafluoride, and some evidence relating to the molecular parameters is obtained. Several vibrational states have been observed, including the torsional vibration from which the height of the potential barrier can be estimated as 220 cm^{-1}.

A.

535.343.4–15

3466. Intensities of vibration bands of carbonyl sulfide and carbon disulfide. D. C. MCKEAN, H. J. GALLOMON AND H. W. THOMPSON. Letter in *J. Chem. Phys.*, **20**, 520 (*March*, 1952).

The integrated infrared absorption intensities for CS_2 at 1 523 cm^{-1} is $7\,700 \times 10^{10}$ cycles/cm at N.T.P. and for OCS at 2 064 and 859 cm^{-1} are 12 900 and 350×10^{10} cycles/cm respectively. The first value agrees with Robinson [Abstr. 7694 (1951)] but the latter pair are higher, possibly as the result of increased purity.

D. H. WHIFFEN

535.343.4–15

3467. Infrared spectrum of SF_6 in the LiF region. A. DE LATTRE. Letter in *J. Chem. Phys.*, **20**, 520–2 (*March*, 1952).

Spectrum of SF_6 from 1 560–2 400 cm^{-1} agrees in outline but not in some details with that of Lagemann and Jones [Abstr. 5286 (1951)].

D. H. WHIFFEN

535.343.4–15 : 535.375.5

3468. Infrared and Raman spectra of fluorinated ethanes. III. The series CH_3–CF_3, CH_3–CF_2Cl, CH_3–$CFCl_2$ and CH_3–CCl_3. D. C. SMITH, G. M. BROWN, J. R. NIELSEN, R. M. SMITH AND C. Y. LIANG. *J. Chem. Phys.*, **20**, 473–86 (*March*, 1952).

For Pt II, see Abstr. 2544 (1951). New infrared spectra have been obtained for gaseous CH_3–CF_3 in the region 20–38 μ, and in the region 2–38 μ for gaseous CH_3–CF_2Cl and CH_3–$CFCl_2$ and CH_3–CCl_3 vapour and liquid, by use of LiF, NaCl, KBr and KRS-5 optics. Raman spectra of gaseous and liquid CH_3–CF_2Cl and of CH_3–$CFCl_2$ and CH_3–CCl_3 in the liquid state have been obtained with a three-prism glass spectrograph of linear dispersion 15 A/mm at 4 358 Å. Depolarization ratios were obtained for all of the stronger Raman bands of the liquids. The spectra are interpreted, a complete assignment of fundamental frequencies is proposed for each molecule, and thermodynamic functions are calculated for the temperature range 298–600°K and at the boiling point.

535.343.4–15 : 535.375.5 : 539.133

3469. The molecular structure of MoF_6, WF_6, and UF_6 from infrared and Raman spectra. T. G. Burke, D. F. Smith and A. H. Nielsen. *J. Chem. Phys.*, **20**, 447–54 (*March*, 1952).

The Raman photographs of MoF_6 and WF_6 exhibit 3 intense lines in accord with earlier measurements on UF_6 in solution. The exploration of the infrared spectra of MoF_6 and WF_6 from 2–40 μ yielded a great many bands for each molecule. Two of these were quite intense in each case and were identified as fundamentals while the remaining weaker ones were identified as overtones and combinations. The infrared spectrum of UF_6 was repeated from 2–17 μ with substantially the same results as in the earlier work. Extension of this spectrum from 17–40 μ was made and 3 new bands were discovered. Because of the great similarity of the spectra of these 3 molecules an interpretation of the bands was made along lines, suggested by Bigeleisen, Mayer, Stevenson and Turkevich for UF_6, that the molecule belongs to the point group O_h and has totally symmetric octahedral structure. It was possible to fit all but 5 very weak bands into an identification scheme based on this model. The success of this effort is taken to be conclusive evidence in favour of the O_h type symmetry. A.

535.343.4–15 : 539.132

3470. The infrared spectrum of nitrosyl fluoride. I. Prism spectrum. P. J. H. Woltz, E. A. Jones and A. H. Nielsen. *J. Chem. Phys.*, **20**, 378–80 (*March*, 1952).

The prism spectrum of NOF is reported from 2–38 μ. Twelve absorption bands were observed and identified in terms of the fundamental frequencies ν^1(N–O) = 1 844·03 cm^{-1}, ν_2 (bending) = 521 cm,$^{-1}$ ν_1(N–F) = 765·85 cm^{-1}. Comparison with the companion molecules NOCl and NOBr is made. A.

535.343.4–15 : 539.132

3471. The infrared spectrum of nitrosyl fluoride. II. Rotational analysis of ν_1 and ν_3. D. W. Magnuson. *J. Chem. Phys.*, **20**, 380–2 (*March*, 1952).

Analysis of the rotational structure of ν_1 and ν_3 infrared bands of nitrosyl fluoride at 1 844·03 and 765·85 cm^{-1} showed that this molecule is nearly a prolate symmetric top. The following rotational parameters based on symmetric-top theory were found and are expressed in cm^{-1}: for ν_1, $2B'' = 0·7515$, $2B' = 0·7483$, $D'_J + D''_J = 0·000027_5$; for ν_3, $2B'' = 0·7521$, $2B' = 0·7503$, $D'_J + D''_J = 0·000002_{36}$. The anharmonic term x_{33} was found to be $-1·06$ cm^{-1} from ν_3. The anharmonic term x_{12} was found to be $+1·03$ cm^{-1} from ν_1. A.

535.343.4–31

3472. On some new band spectra of PbCl, PbBr and PbI radicals. K. Wieland and R. Newburgh. *Helv. Phys. Acta*, **25**, 87–106 (*No.* 1–2, 1952) *In German.*

New ultraviolet band systems ($B \leftarrow X$) have been obtained in the absorption spectra of the thermally decomposed vapours of PbX_2 (X = Halogen). In addition, the hitherto missing visible system ($A \leftrightarrow X$) of PbI has been observed in emission and, faintly, also in absorption. From a vibration analysis of the four new band systems, from predissociation phenomena occurring in all systems (B–X), and from fluorescence experiences made by Popov (1932, 1936) with the vapours of PbX_2, the following most probable values (less probable values in brackets) for the dissociation energy of the radicals PbX can be deduced: PbF 3·22 (3·57), PbCl 3·05 (3·40), PbBr ~ 2·5, PbI 1·98 (1·63) volts. A.

535.343.4–32

3473. Absolute absorption coefficients of nitrogen in the vacuum ultraviolet. G. L. Weissler, P. O. Lee and E. I. Mohr. *J. Opt. Soc. Amer.*, **42**, 84–90 (*Feb.* 1952).

Absorption in nitrogen at wavelengths longer than 796 Å, the Worley–Jenkins Rydberg series limit $^2\Sigma_g^+$, was found to be principally the result of band spectra, whereas below this limit continuous absorption set in, very rapidly reaching a first maximum of k = 680 cm^{-1} near 760 Å and a second one near the limit of the Hopfield–Rydberg series $^2\Sigma_u^+$. From the appearance of the contour of the absorption continuum and from the intensity distribution of the preceding bands, one is led to believe that it was a composite one consisting of two ionization continua adjoining the two Rydberg series limits. The integrated absorption coefficient gave an f-value of 3·3 which was in agreement with the predicted value of 3·27 from classical electron theory. Between 796 Å and 661 Å some very large absorption coefficients were found with $k = 2·76 \times 10^3$ cm^{-1} because of the strong, diffuse bands in this region. Experimental results were internally consistent to about 10% and Beer's law was shown to be obeyed. A.

535.343.4–32

3474. The absorption spectrum in the near ultraviolet of paradifluorobenzene vapour. A. H. Delsemme and J. Duchesne. *C.R. Acad. Sci.* [*Paris*] **234**, 612–14 (*Feb.* 4, 1952) *In French.*

Measured with a Hilger-spectrograph (dispersion 25 Å/m) and a 7 m-grating (dispersion 2·5 Å/mm) at varying pressures and temperatures. 50 bands observed between 2 750 Å and 2 200 Å, corresponding to the band system of benzene at 2 600 Å. The symmetry is reduced from D_{6h} to D_{2h} (A. H. Delsemme [Abstr. 2529 (1951)]). The O–O band is displaced 1 246 cm^{-1} towards the red compared with C_6H_6. The excited state enlarges the C–C bond 0·03 Å, the C–F bond is not changed, and there is a large influence on the rigidity of the C–C–C angles. C. TURNER

535.347.–15 : 541.65

Infra-red dichroism and chain orientation in crystalline ribonuclease. *See Abstr.* 3989

535.371

3475. Luminescence effects associated with the production of silicon monoxide and with oxygen deficit in silica. J. Ewles and R. F. Youell. *Trans Faraday Soc.*, **47**, 1060–4 (*Oct.*, 1951).

The luminescent properties of silica after heating with reducing agents, in reducing and oxidizing atmospheres and *in vacuo* are described. The luminescence of sublimates produced by the reduction of silica is related to the production of silicon monoxide

considerable amounts and the luminescence effects bserved after heating *in vacuo* to the production of me oxygen deficit in the silica lattice. The relation the results to other work on silicon monoxide and recent ideas on the nature of silica surfaces is briefly scussed. A.

535.371

476. Arrangement for the spectral examination of eak luminescence in the near infra-red. G. DÉJARDIN ND R. FALGON. *C.R. Acad. Sci.* [*Paris*] **234**, 200–2 *Jan.* 7, 1952) *In French.*

A prism spectrograph was used with an image nverter tube to give images of the near infrared ectrum on a ZnSSe : Cu screen, and these were notographed with a final dispersion of 725 Å per mm 0·8 μ and 1 680 Å per mm at 1·1 μ. Details are ven of the refrigeration system to maintain the notocathode at about — 40°c in order to minimize ermionic emission. S. T. HENDERSON

535.371

477. On the luminescence of phosphors in strong ectric fields. A. HERWELUY. *Acta Phys. Austriaca*, 30–44 (*No.* 1, 1951) *In German.*

An investigation of the luminescence in sulphide nd other phosphors due to strong applied electric elds is made. For unidirectional fields the emission ccurs only when putting on or taking off the field. he fields necessary range from 12 000 V/cm for a untz ZnS phosphor to 200 000 V/cm for most other hosphors. For high fields a small afterglow effect is bserved. It is shown that the effect of the field in roducing emission is still present when the phosphor *in vacuo*. G. F. J. GARLICK

535.371

478. A study with alkali halide scintillations. BONANOMI AND J. ROSSEL. *Helv. Phys. Acta*, **24**, 10–15 (*No.* 4, 1951) *In French.*

By using pure and thallium-activated alkali halide ystals in a scintillation counter their phosphorescence nd thermoluminescence characteristics are deter-ined. A discussion of the nature of the luminescence nission centres in the pure alkali iodides is given, ased on the experimental results. G. F. J. GARLICK

535.371

479. Determination of the self absorption and elative efficiencies of some important liquid scintil-tors. H. SKÖLDBORN. *Ark. Fys.*, **4**, 207–15 (*Paper* 8, 951).

Measurements are given of the absorption coef-cients and relative efficiencies of scintillating liquids, uch as xylene containing anthracene or terphenyl, ombarded by polonium α-particles. G. F. J. GARLICK

535.371

480. The luminescence of basic magnesium arsenate ctivated by manganese. M. TRAVNIÇEK, F. A. RÖGER, T. P. J. BOTDEN AND P. ZALM. *Physica*, **18**, 3–42 (*Jan.*, 1952).

In the system $MgO–As_2O_5$ there is a compound of e composition $6MgO . 1As_2O_5$. Products containing nall concentrations of Mn show fluorescence upon xcitation by cathode rays or by ultraviolet radiation. ivalent Mn causes fluorescence in a broad band in the green, with a maximum at 5 050 Å; tetravalent causes a red fluorescence in a band consisting of five narrow sub-bands at 6 200, 6 300, 6 400, 6 500 and 6 580 Å. Both bands decay exponentially; the time constant at room temperature is 130 sec^{-1} for the green band and 360 sec^{-1} for the red band. For the red luminescent systems the spectral distributions of the absorption, excitation and fluorescence and the temperature dependence of the intensity of the fluorescence, the fluorescence spectrum and the decay constant have been determined and a quantitative representation of several of these quantities has been given. A.

535.371

3481. The effect of pressure on scintillation phosphors. A. J. REINSCH AND H. G. DRICKAMER. Letter in *J. Appl. Phys.*, **23**, 152–3 (*Jan.*, 1952).

Increasing pressure on a $CdWO_4$ crystal from 1 to 10 000 atmospheres decreases the counting efficiency by 15 to 20% but no such effect is observed for anthracene crystals. The fall in response for $CdWO_4$ is attributed to a shift of its emission band to longer wavelengths. G. F. J. GARLICK

535.371

3482. Electron levels in phosphorescent crystalline solids containing "killer" centres (Fe, Ni, Co). N. ARPIARIAN AND D. CURIE. *C.R. Acad. Sci.* [*Paris*] **234**, 75–7 (*Jan.* 2, 1952) *In French.*

Two energy-level schemes are described which explain the different actions of Ni and Fe impurities on the one hand and Co on the other hand in ZnS phosphors. G. F. J. GARLICK

535.371

3483. The fundamental polarization of luminescence of dyes. Fluorescence and alpha phosphorescence. E. LAFFITTE. *C.R. Acad. Sci.* [*Paris*] **234**, 424–6 (*Jan.* 21, 1952) *In French.*

Using a modified form of the previous apparatus [Abstr. 5295 (1951)] to remove diffused light studies are made of the polarization of fluorescence and phosphorescence of dyes such as fluorescein, rhodamine B, trypaflavine, etc., dispersed in Plexiglass. The degree of polarization is less for the α-phosphorescence than for the fluorescence. G. F. J. GARLICK

535.371 : 530.145.6

3484. Attempts to use wave mechanics in phosphorescence. D. CURIE. *J. Phys. Radium*, **12**, 920–9 (*Dec.*, 1951) *In French.*

Wave mechanics does not give exact explanations of the experimental results for properties of conduction and of trapped electrons but distinguishes the value of the different theories of electron ejection from traps and the nature of the latter. The model of Muto [*Sci. Pap. Inst. Phys. Chem. Res.* [*Tokyo*] **28**, 171 (1935); **32**, 5 (1937)], where the trap is a single metastable level and one absorbed thermal quantum ejects the electron is rejected, and also the idea of successive absorption of quanta by the trapped electrons. It is shown that an electron just leaving a trap is described by a wave packet of Bloch functions which rapidly expands, the electron state being non-stationary. G. F. J. GARLICK

535.375.5

3485. Some remarks on the Raman spectrum of seignette salt. J. CHAPELLE AND A. GALY. Letter in *J. Phys. Radium*, **13**, 111–12 (*Feb.*, 1952) *In French.*

Discussion of Abstr. 979 (1951).

535.375.54

3486. Spectrum of internal vibrations of crystallized oxalic acid. R. MARIGNAN AND L. BARDET. *C.R. Acad. Sci.* [*Paris*] **234**, 714–16 (*Feb.* 14, 1952) *In French.*

The positions and relative intensities of Raman lines observed in the frequency range 51–1 749 cm^{-1} for oxalic acid dihydrate are given. Measurements of depolarization factors and determination of symmetry type for each observed frequency have been made.

G. I. W. LLEWELYN

535.375.54 : 548.7

3487. The orientation of NH_4 ions in ammonium halide crystals. J.-P. MATHIEU AND L. COUTURE-MATHIEU. *C.R. Acad. Sci.* [*Paris*] **233**, 1595–7 (*Dec.* 19, 1951) *In French.*

Measurement of the depolarization factor of Raman rays indicates that the orientation of NH_4 ions in cubic crystals of NH_4Cl and NH_4Br is different from that in cubic crystals of NH_4I. W. R. ANGUS

535.375.55

3488. Configuration of the uranyl ion. J. SUTTON. Letter in *Nature* [*Lond.*] **169**, 235–6 (*Feb.* 9, 1952).

Although it has been shown that the uranyl ion in crystals is linear, in solution the bending and the asymmetric vibrations have been observed in Raman spectra. It is shown, by Raman spectra of different complex uranyl compounds, that this must be due to strong local fields. The intensity of ν_3 increases with the number of complexed ions. ν_2 is not resolved from the exciting line because of the low dispersion of the apparatus used. A. J. TAYLOR

535.375.56

3489. Rotational structure of the ν_3 Raman band of methane. B. P. STOICHEFF, C. CUMMING, G. E. ST. JOHN AND H. L. WELSH. *J. Chem. Phys.*, **20**, 498–506 (*March*, 1952).

A multiple reflection Raman tube and a high-dispersion quartz spectrograph were used to investigate the fine structure of the ν_3 band of gaseous methane. Sixty-eight maxima were measured and evidence for all but one of the 15 theoretically predicted sub-branches was found. An evaluation of the rotational constants by combination relations for Raman and infrared frequencies gives three different B values for the upper vibrational state and surprisingly, three for the ground state. A more acceptable analysis, based on a single set of rotational constants for the ground state, $B_0 = 5{\cdot}253\ cm^{-1}$ and $D_0 = 1{\cdot}9 \times 10^{-4}\ cm^{-1}$, leads to B_1 values for the various branches in the range $5{\cdot}202$ to $5{\cdot}235\ cm^{-1}$. The analysis gives $\nu_0 = 3\,018{\cdot}7\ cm^{-1}$ and $\zeta_1 = 0{\cdot}056$. The constants obtained for the ground state are also used in an analysis of the $2\nu_3$ infrared band. A.

535.376

3490. On the fluorescence produced by α-particles in solutions. II. M. AGENO AND R. QUERZOLI. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **11**, 348–51 (*Dec.*, 1951) *In Italian.*

Continuation of the authors' experiments [Abstr. 1667 (1952)] indicates that electromagnetic radiations produced by α-particles bombarding the solvent mols. are absorbed by the solute mols., the energy being then re-emitted as a characteristic fluorescence; this is mostly in the region 3 000 Å. J. GRANT

535.376 : 532.7

3491. High energy induced fluorescence in organic liquid solutions (energy transport in liquids). III. M. FURST AND H. KALLMAN. *Phys. Rev.*, **85**, 816–25 (*March* 1, 1952).

For Pt II, see Abstr. 4301 (1951). Experimental results on the fluorescence of a large number of efficient solutions under both γ-ray and α-particle excitation are presented. These results are compared with the theory to be found in Pt I, and very good agreement is obtained in almost all cases. The physical efficiencies of some of these solutions under γ-ray excitation are found to be quite high when compared with an anthracene crystal. The light output for the same amount of absorbed energy is considerably less for α-particle excitation than for γ-rays in all of the solutions. The experimental data are discussed in conjunction with the theoretical considerations, and the physical processes involved in the large fluorescence of the solutions are analysed. A.

535.39

3492. Heat-transmitting mirror. G. L. DIMMICK AND M. E. WIDDOP. *J. Soc. Mot. Pict. Televis. Engrs*, **58**, 36–42 (*Jan.*, 1952).

Radiant energy incident upon a glass plate can be divided into transmitted and reflected bands by the interference effect in thin films of dielectrics deposited on the glass. The mirror described here reflects over 95% of incident visible light and transmits a large part of the energy beyond 7 000 Å. Such mirrors have been produced and typical transmission characteristics are shown. Several arrangements for use of such a mirror with a carbon arc are also shown. A.

535.39 : 535.41

3493. Optical thickness of an etalon or Fabry–Perot interference filter with complex semi-transparent mirrors. C. DUFOUR. *Rev. Opt.* (*Théor. Instrum.*) **31**, 1–16 (*Jan.*, 1952). Also published as Letter in *J. Phys. Radium*, **12**, 888–9 (*Nov.*, 1951) *In French.*

A method is given for calculating transmission factors of complex thin films, especially for the case of symmetrical complex "low-high" multiple layers. The method of calculation is given in detail for layers on glass or metal of zinc-sulphide and cryolite, calculations being given for up to seven layers. The calculations are confirmed experimentally. Parasite transmission bands are discussed. S. TOLANSKY

535.39 : 535.417

3494. The determination of the optical constants and the thickness of moderately thick films making use of the absolute phase. H. SCHOPPER. *Z. Phys.*, **131**, 214–24 (*No.* 2, 1952) *In German.*

The general rigid calculation for complex amplitudes on reflection at a thin film can be solved using the optical constants if the absolute phase is known

o assumptions or limitations about film thickness id absorptions need be made. The film thickness n be calculated from two independent complex uations and there are no disturbances due to any entual anisotropy. To test the new method, periments are reported on antimony sulphide, which practically absorption-free. S. TOLANSKY

535.39 : 539.234

495. On the optical properties of very thin metallic ms. F. ABELÈS. *C.R. Acad. Sci.* [*Paris*] **234,** 198–9 *an.* 7, 1952) *In French.*

An earlier theory permitting derivation of the flecting coefficient against air and against glass and so the transmission factor is tested on experimental alues for evaporated gold films and cathodically pattered silver films. Thicknesses are in the range -3·5 μ. The calculated values are not exactly those easured, but the differences between the two reflecting efficients are only some units in the third decimal lace. Considerations are given to the wavelength ariation. See also Abstr. 988 (1951). S. TOLANSKY

535.39–15

496. The infrared properties of gold smoke eposits. L. HARRIS AND J. K. BEASLEY. *J. Opt. oc. Amer.*, **42,** 134–40 (*Feb.*, 1952).

An interpretation of the infrared optical properties f gold smoke deposits is presented together with new xperimental results. This interpretation is based on n application of classical electromagnetic theory. he gold smoke deposits are assumed to interact with nfrared radiation as if they were sheets of an essenally uniform material which is characterized by an verage electrical conductivity small compared with nat of ordinary metals. The electrical conductivity f gold black deposits is found to be $\sim 10^{-5}$ times nat of bulk gold, and the volume per cent of gold in a old black deposit is found to be $\sim 0{\cdot}2\%$. A.

535.41/.42

497. Diffraction and interference in parallel monoromatic light with a circular aperture half covered y a glass plate. E. CHARRON AND N. SEGARD. *.R. Acad. Sci.* [*Paris*] **234,** 610–12 (*Feb.* 4, 1952) *In rench.*

With an extended source and the system described nly a uniform field of the illumination is seen. This explained by regarding the diffraction from the two alf-circles of the diagram which have a phase reardation. On the contrary, with a narrow linear ource fringes can be produced. These are discussed some detail. S. TOLANSKY

535.41

498. Transmission zone plates. J. H. LEE. Letter *Amer. J. Phys.*, **20,** 114 (*Feb.*, 1952).

The author recalls that transmission zone plates n be used to form virtual images and that he had in 940 demonstrated this property experimentally. The pplication to X-ray focusing was found to be of ttle value. R. W. FISH

535.412

499. Theory of an experiment by Dufour and unier. A. METZ AND F. PRUNIER. *C.R. Acad. Sci. aris*] **234,** 185–7 (*Jan.* 7, 1952) *In French.*

Light is sent in two directions around a polygonal path by a series of mirrors mounted upon a turntable. Interference fringes are formed by the two beams of light when the table is stationary. The theory is given for the shift of fringes when the table is rotating and when a cylinder of water is placed in one arm of the polygon. R. W. FISH

535.417

3500. A note on the resolving power of the Fabry–Perot interferometer. J. H. JAFFE. Letter in *Bull. Res. Coun. Israel*, **1,** 113–14 (*March*, 1951).

It is established experimentally with a small-gap Fabry–Perot interferometer that the prediction made by Tolansky [Abstr. 1798 (1944)] as to the dependence of resolution on polarization is correct. S. TOLANSKY

535.417

3501. An arrangement for measuring the angle of incidence of the beam in a Fizeau–Pérard interferometer. J. HAMON. *Rev. Opt.* (*Théor. Instrum.*) **30,** 366–8 (*Aug.–Sept.*, 1951) *In French.*

When length standards are required to be known to one in 10^7 a correction due to non-normal incidence is needed. A method for evaluating this is described. S. TOLANSKY

535.417

3502. A photometric precision method for measuring absolute light phases with the aid of a phase uniform field of view. R. FLEISCHMANN AND H. SCHOPPER. *Z. Phys.*, **131,** 225–30 (*No.* 2, 1952) *In German.*

In interference dispositions with two or more light beams, varying phase differences appear across the field of view as a result of path differences. If the two beams are mutually perpendicularly polarized the phase differences can be compensated with a quartz prism leading to a uniform illumination. If a phase-shifting plate be introduced into one beam the intensity varies corresponding to a phase change of 0 to 180°, leading to a transition from maximum to minimum. If a phase-changing plate is absorbing, then the same method can still be applied. A half-shadow technique can be used. S. TOLANSKY

535.417

3503. The employment of a Savart double plate for the production of a phase uniform field of view. A. LINDBERG. *Z. Phys.*, **131,** 231–3 (*No.* 2, 1952) *In German.*

The interference fringe pattern of a Savart double plate between crossed polarizers can be imaged with a lens such that it corresponds to a quartz wedge. The method described is applicable for the measurement of absolute light phases. Although the quartz wedge gives fringes of equal thickness and the Savart plate of equal inclination, the introduction of a half-wave plate permits the effects to be equalized.

S. TOLANSKY

535.417

3504. Interferometer for the study in white light of variations of optical path. M. FRANÇON. *C.R. Acad. Sci.* [*Paris*] **234,** 311–13 (*Jan.* 14, 1952) *In French.*

An interference method is described enabling aberrations of optical systems to be studied. The lens system is illuminated with a parallel beam of polarized light, the image formed being at the focal plane of another (good) lens which sends the beam

through a Savart polariscope which doubles the wave front. With crossed polarizers and a perfect lens a blank field is seen. With an imperfect lens fringes appear and lens aberrations can be deduced. The colour sensitivity is discussed. S. TOLANSKY

535.42

3505. An experimental study of diffraction showing the boundary effect. A. P. THATTE. *J. Opt. Soc. Amer.*, **42**, 166–71 (*March*, 1952).

This work was undertaken with a view to study the effects which may be produced in the Fresnel diffraction patterns of narrow obstacles, keeping the boundary the same (namely straight) and changing the shape of the cross-section. Visible monochromatic light was used as a source and photometric analysis of the intensity distribution patterns was made. The experimental curves deviate from those obtained according to the classical Fresnel–Kirchhoff theory of diffraction and show a boundary effect. If a comparison of the experimental curves for tapes and wires is made with the theoretical curves, the tape curves appear to be a little better in agreement than the wire curves. Additional experiments performed indicate that the observed deviations are not the result of surface reflections from the obstacles. A.

535.42 : 534.522.1

3506. On the theory of the diffraction of light by supersonic waves. I–II. R. MERTENS. *Simon Stevin*, **27**, 212–30 (1949–50); **28**, 1–12 (1950–51).

A general solution of the problem of the diffraction of light by standing and progressive ultrasonic waves is given. The direction of the diffracted beam and the frequency changes are shown to be in agreement with experiment. Simple formulae are derived for the intensities of the zero and $\pm$ 1st orders in the case of weak ultrasonics, and it is shown that the intensities of the $\pm$ 1st orders for the standing wave are half those for the corresponding progressive wave. 24 references. R. W. FISH

535.42 : 534.522.1

3507. Diffraction of light by standing supersonic waves. General theory. R. MERTENS. *Simon Stevin*, **28**, 164–80 (1950–51).

The diffraction phenomenon is described by a system of difference-differential equations, the solutions of which are the amplitudes of the different spectra. A method of integrating these equations is given, and solutions quoted enabling the amplitudes to be calculated. R. W. FISH

535.421

3508. The reduction of ghosts in diffraction grating spectra. N. A. FINKELSTEIN, C. H. BRUMLEY AND R. J. MELTZER. *J. Opt. Soc. Amer.*, **42**, 121–6 (*Feb.*, 1952).

False lines appearing in grating spectra as a result of periodic errors in the shape or location of the ruled grooves are commonly called ghosts. Periodic errors in the first Bausch and Lomb engine and the resultant ghosts are discussed with reference to the Rowland and Runge theories of false spectra. With the assistance of an interferometric error recorder for determining ruling engine errors directly, correction cams have been cut and gratings ruled with less than 0·025% relative ghost intensity measured at 5 461 Å in the first order of a 600-groove/mm grating. Finally, it is shown that gratings may be designed for specified analytical problems in such a manner that the residual ghosts fall outside the region of operation. A.

535.43

3509. Breakdown of the Lambert–Beer law. H. E. ROSE. Letter in *Nature* [*Lond.*] **169**, 287–8 (*Feb.* 16, 1952).

From measurements of the transmission of powder suspensions it is concluded that deviations from the law are greater with powders of high reflectivity and with a receiver large enough to collect an appreciable quantity of scattered light. G. F. LOTHIAN

535.435

3510. The light scattering by non-spherical particles in solutions. N. SAITÔ AND Y. IKEDA. *J. Phys. Soc. Japan*, **6**, 305–8 (*Sept.–Oct.*, 1951).

The angular distribution of the intensity of light scattered by macromolecules in solution has been calculated numerically, assuming these molecules to be ellipsoids of revolution and cylinders whose dielectric constant is slightly different from that of the solvent. The results are given in graphs and they will be useful for the determination of the shapes of large protein molecules such as vaccinia virus. A.

535.543

3511. Polarization and interference maxima in spectra of the visible and ultra-violet region. L. V. SMIRNOV. *Zh. Tekh. Fiz.*, **21**, 1486–91 (*No.* 12, 1951). *In Russian.*

Analyses bands occurring in the quartz spectrograph spectra of polarized light and due to the rotatory dispersion of the plane of polarization and to the fact that the front face of the dispersing prism acts as an analyser. The number of maxima and minima is determined not only by the change of rotatory dispersion with wavelength, but also by the total length of the optical path traversed by polarized light. The number and arrangement of these maxima is constant for each spectrograph, provided there is no optically active body in front of the slit; the picture is shifted towards longer or shorter wavelengths when such a body is inserted between the polarizer and the slit. A diagram of the calculated maxima for 3 different quartz thicknesses, and a graph showing the blackening curves obtained with both the ordinary and polarized light (plane parallel or at right angles to the slit) are presented. It is stressed that quartz should be replaced by another material combining a good transmissivity in the ultraviolet with optical inactivity. Another method of eliminating the polarization maxima consists in using a collimating lens doublet made of right and left quartz. It can be said that, with the existing quartz spectrographs, photographic spectrophotometry using polarized light ceases to be accurate at *c.* $\lambda = 2\,500$ Å. Other disturbances occur in the absorption spectra of thin films due to the formation of interference bands when the specimen has an appropriate thickness. When this thickness is small, the width of interference bands in the ultraviolet becomes comparable with that of the polarization maxima and of the absorption bands, and, consequently, no accurate quantitative photometry is possible. The thickness of films can be

etermined from the interference lines in the absorption spectra. Any inequality of specimen thickness lown to $\frac{1}{20}$ of the thickness) can be evaluated by the ıethod of line coincidence. Distortions due to a ɔcal change of the *nd* product (oblique or curved ıterference lines) can be used for the evaluation of *d*, the accuracy of this method being dependent ltimately on the sharpness and width of the lines; ıat is why reflected light (silvered surfaces) is often sed. Despite the increase of width and decrease of ıarpness of the lines, it is advantageous to conduct ıeasurements in ultraviolet, owing to the rapid rise f dispersion with decreasing wavelength. Examples f direct determination (without microphotometer) of ıe interval λ_2–λ_1 are given for glass and mica ımellae. F. LACHMAN

535.543

512. On hypersensitive polarization colors. H. Kubota. Letter in *J. Opt. Soc. Amer.*, **42**, 144–5 (*Feb.*, 1952).

A method of getting colours that are more sensitive ıan those obtained earlier [Abstr. 7786 (1951)] is escribed. Previously a birefringent plate of phase ifference δ was placed between parallel Nicols. Jow a phase difference η, independent of the wave-ıgth used, is added so that the resultant phase ifference is $(\eta + \delta)$. This produces a more sensitive olour than with δ alone and the sensitivity is theo-ɛtically greater the nearer η is to π. The method of roducing the achromatic retardation is described: it tilizes internal reflection in glass. Plastic sheets are sed as birefringent plates. H. G. JERRARD

535.543

513. The calibration of quarter-wave plates. I. G. Jerrard. *J. Opt. Soc. Amer.*, **42**, 159–65 (*March*, 1952).

The experimental procedure and the underlying ıeory of several methods of calibration are given. 'he best method has been found to be one in which bservation is made on a channelled spectrum, where ıe channelling is the result of multiple reflections in a lane parallel plate. The wavelength for which the late is a $\lambda/4$ plate can be found easily to within 10 Å. hotographs are given to illustrate the channelled ɔectrum method, and the results of a detailed analysis f the accuracy of this method are shown graphically. method to get higher precision is indicated. The ffect of multiple reflections on the phase difference of ıe plate to be calibrated is discussed. Some theo-ɛtical and practical details of construction, with par-ɔular reference to mica plates, are mentioned. A.

535.543 : 535.65

514. On the color of chromatic polarization. T. Kubota. Note in *J. Phys. Soc. Japan*, **6**, 405–6 (*Sept.–Oct.*, 1951).

A crystal plate, *C*, of phase difference δ, placed ɛtween two Nicols acting as polarizer, *P*, and ıalyser, *A*, gives interference colours with white ght illumination. These are usually described ıbjectively. The dominant wavelength λ is deter-ined by δ. If the vibration directions of *P* and make angles of ρ and θ respectively with the main bration direction of *C*, then the purity of the colour expressed by a factor ε, which is a function of ρ and θ. A graph is given of θ against ρ for different values of ε. For any values of ρ and θ a value of ε can be read off and this together with a graph published previously [see Abstr. 5746 (1950)] which gives λ, enables the colour to be described objectively. H. G. JERRARD

535.55 : 530.162 : 539.31

Stress birefringence of rubber-like materials—statistical theory. *See Abstr.* 3916

535.55 : 548.12

3515. Photoelasticity in crystals. F. G. Fumi. Letter in *Nuovo Cim.*, **9**, 184–5 (*Feb.*, 1952).

Bhagavantam [Abstr. 1803 (1943)] has pointed out errors in schemes for symmetries C_3, S_6; C_{3h}, C_6, C_{6h}; C_4, S_4, C_{4h}; and T, T_h in the polar tensor theory of photo-elasticity. The corrected schemes are given. The consequences of these schemes are discussed, it being concluded that it should be possible to make crystals of symmetries C_3, S_6; and C_{3h}, C_6, C_{6h} become optically biaxial by a pure shear in the plane perpendicular to the principal axis. Crystals of symmetries C_4, S_4, C_{4h} are more complicated. Symmetries T and T_h have been experimentally verified [Abstr. 4256 (1949)]. H. G. JERRARD

535.58

3516. Dispersion of the electric and magnetic birefringences of liquids. R. Servant. *Rev. Opt.* (*Théor. Instrum.*) **30**, 453–70 (*Nov.*, 1951) *In French.*

The author discusses, and gives a general explanation of, the formula $\beta = b\lambda/(\lambda^2 - \lambda_1^2)$, proposed previously [R. Servant, *C.R. Acad Sci.* [*Paris*] **211**, 780 (1940); *J. Phys. Radium*, **4**, 105 (1943); Abstr. 6419 (1950)] for the variation of the Kerr and Cotton–Mouton effects with wavelength. The significance of the wavelength λ_1, characteristic of the birefringence, is specified. The method of calculation, from the Langevin–Born orientation theory, of the constant b is described and its value as a connection between dispersion and molecular characteristics discussed. The formula is applied to the results of Szivessy and Dierkesmann (1929) on the electric birefringence of hexane, and Szivessy (1922) and Davis (1940) on the magnetic birefringence of nitro-benzene. It is regarded as highly satisfactory. H. G. JERRARD

535.6.08

3517. Uniformity of designations in colorimetry. G. N. Rautian. *Zh. Tekh. Fiz.*, **21**, 597–8 (*No.* 5, 1951) *In Russian.*

It is suggested, in order to avoid confusion: (1) to use X_0, Y_0, Z_0 for the co-ordinates of the international system of co-ordinates, while X, Y, Z ought to designate the colour components along the axes of this system; (2) x, y, z should be used solely for the trichromatic coefficients; (3) other lower-case letters should be used for the trichromatic co-ordinates of the international system; and (4) $\alpha(\lambda)$, $\beta(\lambda)$, $\gamma(\lambda)$ should be used instead of $\bar{x}$, $\bar{y}$, $\bar{z}$ for designating the co-ordinates of the equal-energy spectrum. F. LACHMAN

535.611

3518. Color tolerance specifications for paint. T. F. Boyd. Letter in *J. Opt. Soc. Amer.*, **42**, 141 (*Feb.*, 1952).

The method used for calculating colour differences

in work on colour tolerances [see Abstr. 7788 (1951)] is not quite rigorous but gives results which agree tolerably with those obtained by the rigorous method. J. W. T. WALSH

535.65

3519. On the number of absolutely identifiable spectral hues. R. M. HALSEY AND A. CHAPANIS. Letter in *J. Opt. Soc. Amer.*, **41**, 1057–8 (*Dec.*, 1951).

The memory for spectral colours was trained and tested in four observers. Four series of spectral hues consisting of 17, 15, 12 and 10 samples (visual angle = 45′) were presented and the percentage P of correct identifications determined. P rose from 72·4 for 17 hues to 97·5 for 10 hues. The luminances were equated for λ's > 494 mμ. The "true series of absolutely identifiable spectral hues" is thought to consist of less than 12. R. A. WEALE

535.65

3520. The measurement of colour. H. COTTON. *Beama J.*, **59**, 3–10 (*Jan.*); 37–45 (*Feb.*, 1952).

The first part consists of a general description of the principles of colorimetry with particular reference to the C.I.E. system. The second part describes (i) the principal forms of colorimeter now in use, including an instrument designed by the author in which any desired number of stimuli may be employed, and (ii) spectrophotometers, both visual and photoelectric, including instruments for abridged spectrophotometry in selected bands of wavelengths. J. W. T. WALSH

535.7 : 612.84

Physiological optics. *See Abstr.* 4064–6

535.822 : 535.417

3521. A microscope interferometer using double refraction with white light and without doubling. M. FRANÇON. *C.R. Acad. Sci.* [*Paris*] **234**, 423–4 (*Jan.* 21, 1952) *In French.*

A method formerly described, using a Savart polariscope [Abstr. 941 (1952)] is extended to microscopic observation. Whilst formerly the polariscope was placed between the object and objective, it is shown to be advantageous to place the object between the two plates of the polariscope. S. TOLANSKY

535.822 : 535.417

3522. The application of uniaxial plates to the observation of isotropic or non-isotropic transparent objects in microscopy. M. FRANÇON. *C.R. Acad. Sci.* [*Paris*] **234**, 520–1 (*Jan.* 28, 1952) *In French.*

A previous paper [Abstr. 941 (1952)] described a method, using a Savart polariscope, by which an object is seen doubled in "phase contrast." The present paper gives a modification of the method with a uniaxial crystal plate in which either image may be suppressed. R. W. FISH

535.822.9

3523. Combined phase-contrast and interference-contrast microscopy. R. BARER. Letter in *Nature* [*Lond.*] **169**, 108–9 (*Jan.* 19, 1952).

Phase contrast is combined with the interference microscope method in which a biological specimen is maintained between silvered surfaces. By combining phase contrast with interference contrast critical changes of phase such as occur within broad details can be made apparent if variations in intensity occur. S. TOLANSKY

535.822.9 : 535.41

3524. The observation of transparent objects by the method of Tolansky. M. FRANÇON. *Rev. Opt.* (*Théor. Instrum.*) **30**, 221–34 (*May*, 1951) *In French.*

A mathematical analysis is made of the contrast sensitivity of the multiple-beam interference method which enables small phase objects to be seen in high contrast. The sensitivity of the interferometric method is compared with that of phase contrast, and is shown to be somewhat less sensitive. The intensity in the image is shown to be proportional to the phase introduced by the object. The conditions of line width and effect of source diameter are discussed. It is considered that in general the interferometric method is on the whole more delicate than that of phase contrast. S. TOLANSKY

535.822.9 : 535.41

3525. Interference by double refraction in white light. New method of observation of transparent objects. M. FRANÇON. *Rev. Opt.* [*Théor. Instrum*] **31**, 65–86 (*Feb.*, 1952) *In French.*

The dephasing object to be studied is shown by interference against a coherent background taken near the object and shifted not only in depth but also laterally. The shift in depth adjusts the path difference between the image and the coherent background, the lateral shift gives interference with different parts of the object. The method is easily applied to an ordinary microscope without changing any of its components and can be used by transmission or by reflection and in white light. Its fundamental advantage is its simplicity; there are practically no difficulties in the adjustment, contrary to other interference methods. A.

535.87

3526. On an adjustable mirror mounting. G. K. T. CONN AND G. K. EATON. Letter in *J. Opt. Soc. Amer.*, **42**, 143–4 (*Feb.*, 1952).

535.89

3527. Laboratory source of 1·08 μ and 2·06 μ monochromatic radiation. R. H. MCFEE. Letter in *J. Opt. Soc. Amer.*, **42**, 67 (*Jan.*, 1952).

A He discharge tube of the Geissler type gives two spectral lines at 1·08 μ and 2·06 μ in the infrared. Filters are described which allow the isolation of either line. The variation of radiant energy with applied voltage is shown for both wavelengths. R. W. FISH

535.89

3528. A constant intensity vacuum spectroscopic light source. PO LEE AND G. L. WEISSLER. *J. Opt. Soc. Amer.*, **42**, 80–4 (*Feb.*, 1952).

A vacuum spectroscopic light source was developed which furnished a constant intensity emission line spectrum. Reproducibility was achieved by controlling with an oscilloscope the spark breakdown potential and the number of breakdowns per cycle of the applied high voltage. The gas composition in the source was found to be critically important. The constancy was checked photometrically and found to be about 2%. A.

536.2 : 621.365.55

9. Temperature distribution with simultaneous tten and dielectric heating. H. M. NELSON. *t. J. Appl. Phys.*, **3**, 79–86 (*March*, 1952).

The temperature distribution in a solid of infinite a bounded by two parallel planes in which heat eing uniformly generated and the surfaces of which maintained at an elevated temperature is evaluated the case in which the solid is initially at a uniform nperature throughout. A comparison is made ween platten and combined heating which shows t the heating time can be divided by a factor which ends on the tolerable temperature variation, but ich is of the order of 10 for a variation of 19% and for a variation of 1·2%. Some consideration is en to the optimum conditions required for the ting of synthetic resins and like materials for which setting time is a function of the temperature. actical considerations which restrict the choice of ne of the parameters are mentioned. A.

536.21

30. The thermal conductivity of soil. A. GEMANT. *ch. elekt. Übertragung*, **5**, 539–43 (*Dec.*, 1951) *In rman.*

For the operation of h.v. cables the knowledge of thermal conductivity of the soil is important. nder the assumption that the particles of the soil are smatic with pyramidal ends the conductivity is nputed and the theory is able to explain quantitaely the influence of the following factors: density of cking, content of humidity, composition of the l and temperature. There is fair agreement tween the values computed by the aid of the theory d experimental values published in literature. As s previously stated [Abstr. 7184 (1950)] an average istivity value of 60 to 70 thermal ohms is obtained average values of humidity as against 80 ohms quently used in cable technique. R. NEUMANN

536.21 : 548

31. New data on the thermal conductivity of tical crystals. K. A. MCCARTHY AND S. S. LLARD. Letter in *J. Opt. Soc. Amer.*, **41**, 1062–3 *ec.*, 1951).

A crystal of known conductivity is placed upon the known one with a copper plate between them. A urce of heat is superposed on the crystal pile and the nperature gradients across the two crystals are asured. Values for cubic and non-cubic crystals tabulated and discussed. E. H. DOCK

536.212.2 : 621.315.5.017.7

32. The steady-state temperature of current-rying long wires. J. FISCHER. *Arch. Elektrotech.*, 262–74 (*No.* 4, 1952) *In German.*

See Abstr. 945 (1952). A long linear conductor of nstant cross-section q and perimeter u, surrounded a fluid or *in vacuo*, is considered. The steady-state nperature excess $y = (T - T_0)$ of the wire above surroundings (T_0) is given by $qj(y) - uw(y) = 0$ ere $j(y)$ denotes the Joule heat and $w(y)$ the rate loss of heat from the surface. It is shown that y) may be expressed as $a_0y + a_2y^2 + a_3y^3 + \ldots$. utions for the cases $w = a_0(y)$; $a_0y + a_2y^2$; $a_0y + a_3y^3$; $\sigma T_0^4(\theta^4 - 1)$ and $sT_0^5(\theta^5 - 1)$, where $\theta = T/T_0$, under the conditions of constant current, terminal voltage or power are obtained. The relations between the terminal voltage, the dimensions and temperature for the 5 cases are derived. Some of the solutions and relations are shown graphically.

S. WEINTROUB

536.22

3533. Thermal conductivity of fluid argon and nitrogen. A. UHLIR, JR. *J. Chem. Phys.*, **20**, 463–72 (*March*, 1952).

The thermal conductivities of A and N have been measured at pressures up to twice the critical pressures and at temperatures from the normal boiling points to well above the critical temperatures. By combining Enskog's transport theory for a dense gas of hard elastic spheres with free volume calculations for a close-packed lattice (assuming a communal entropy of R per mole), one can calculate the thermal conductivity λ for liquid A between 87·3°K and 141·6°K from liquid and vapour densities and entropy of vaporization. The values so calculated are within 15% of the measured values. However, a similarly calculated value of the viscosity is 50% lower than the experimental value. A correction for quantum-mechanical effects reduces the disagreement between the theoretical and experimental values of λ to about ±5%, which is within the uncertainty of the thermodynamic data. A.

536.222

3534. The thermal conductivity of ammonium chloride in the region of the II–III transition point. C. V. SIMSON. Note in *Naturwissenschaften*, **38**, 559, (*No.* 24, 1951) *In German.*

A cylinder of NH_4Cl was used and measurements made in the range 235°–273°K. The curve shows a marked change in shape at 242·7°K, where the specific heat has a maximum value. E. H. DOCK

536.24 : 536.48

3535. Heat exchange in hydrogen boiling under atmospheric pressure. L. WEIL AND A. LACAZE. Letter in *J. Phys. Radium*, **12**, 890 (*Nov.*, 1951) *In French.*

Gives results of measurements of energy transfer to the liquid from metal surfaces with excess temperatures 0·2°C–200°C. R. O. DAVIES

536.4.031

3536. Kinetics of solidification of supercooled liquid mercury droplets. D. TURNBULL. *J. Chem. Phys.*, **20**, 411–24 (*March*, 1952).

The solidification rate of supercooled liquid Hg droplets is strongly dependent upon the nature of foreign substances on their surface or suspended in them. Droplets (2–8 microns dia.) coated with Hg laurate solidify at rates that are proportional to droplet volume and satisfactorily described by the theory of homogeneous nucleation of crystals. Droplets coated with Hg acetate solidify with frequencies that are proportional to droplet area and in good agreement with the theory of heterogeneous nucleation. The results on Hg_2I_2-coated droplets are interpreted on the hypothesis that nucleation is effected by suspended crystallites of one kind. For

some droplet dispersions the kinetic results are apparently best described by a multiplicity of solidification frequencies/area or volume. Various hypotheses for this multiplicity are considered. A.

536.41 : 621.317.79

3537. A recording dilatometer for high temperatures. W. R. Apblett and W. S. Pellini. *Amer. Soc. Metals, Prepr. No. 2W*, 15 *pp.* (1951).

A new method which permits extension of dilatometry to temperatures much above the present limit of 980°C. The method consists of electrical resistance heating of a small rod-like specimen. Temperatures and resulting dilations are recorded by means of thermocouples and SR–4 clip gauges respectively. Heating rates of 280°c/sec are readily attainable. Data are presented of the linear expansions of various high-temperature alloys to 1 315°C, molybdenum to 1 650°C and tungsten to 2 630°C. METROPOLITAN-VICKERS

536.421.4.08

3538. A differential heat-loss freezing-point apparatus. I. M. Bernstein. *J. Phys. Coll. Chem.*, **55**, 1231–9 (*Oct.*, 1951).

536.422

3539. Sublimation and condensation of carbon dioxide, nitrogen and oxygen in an expansion chamber. B. M. Cwilong and M. H. Edwards. Letter in *Phys. Rev.*, **85**, 380–1 (*Jan.* 15, 1952).

Expansions were performed in a chamber precooled to −100°C and containing saturated vapour of CO_2 in a He atmosphere. Expansion below a threshold value of 1·2 gave no crystals but above it abundant showers of CO_2 crystals occur while the number of crystals increases up to an expansion value of 1·4. Sublimation therefore occurs and there is a definite threshold which is defined in terms of an expansion ratio and not of temperature. N_2 and O_2 show very low condensation thresholds. Below their triple points both vapours form homogeneous stable supercooled droplet clouds. Solid N_2 crystals were first observed in N_2 droplet clouds at an expansion ratio of 5. No O_2 crystals occur even with expansion ratios up to 10. R. S. READ

536.423.15

3540. The vapour pressure of liquid krypton. A. Michels, T. Wassenaar and T. N. Zwietering. *Physica*, **18**, 63–6 (*Jan.*, 1952).

The vapour pressure has been measured between triple point and critical point. The results are represented as a function of temperature by the formula $\log P = A/T + B \log T + CT + D$. A.

536.423.4

3541. On the theory of condensation. M. Fierz. *Helv. Phys. Acta*, **24**, 357–66 (*No.* 4, 1951) *In German.*

Applying statistical mechanics to a gas whose atoms are mutually attracted, the condensation point is shown to be a singularity in the equation of state, in which the pressure assumes a well-defined value whereas the density is undertermined. T. C. TOYE

536.423.4 : 548.528

Condensation on ions in cloud chambers. *See Abstr.* 4008

536.424.1 : 537.226.2

Phase transition in lead zirconate. *See Abstr.* 3568

536.424.1 : 537.226.

On the phase transition in barium-lead titanat *See Abstr.* 3569

536.4

3542. A method for the measurement of the tem perature distribution in the inner cone of a Bunse flame. G. Dixon-Lewis and M. J. G. Wilson *Trans Faraday Soc.*, **47**, 1106–14 (*Oct.*, 1951).

The deflections of the edges of a very narrow bea of light were recorded photographically at a numbe of distances 0·1 mm apart through the flame fro of a 9·7% methane + air flame. From these d flections, the temperature distribution in the flam front can be calculated very approximately. Th time of passage of the gases through the temperatu gradient was found to be about 10^{-3} sec, whilst th time of passage through the actual reaction zone only of the order of 10^{-4} sec. The temperature which reaction appears to commence is discussed.

536.4

3543. Flame propagation: the measurement burning velocities of slow flames and the determinatio of limits of combustion. A. Egerton and S. K Thabet. *Proc. Roy Soc. A*, **211**, 445–71 (*March* 2 1952).

A method of measuring burning velocities combustible gas/air mixtures near the limits combustion is developed, using a burner providing flat disk-shaped flame. The method is applied t methane, propane, *n*-pentane, *n*-heptane, ethylen acetylene and benzene flames of velocities 5 to 10 cm/ The characteristics of the burner and the flames a discussed; the time during which unburnt gas can b heated by conduction from the flame appears to b insufficient for purely thermal initiation, and th reactions are therefore probably started by diffusio of radicals from the flame front. The burnin velocities of these slow flames are mainly depende on reaction heat which determines the temperature the flame and the rate of the reactions. The effe of some additives (½% by volume) on the burnin velocities in the range investigated and on the low limits is thermal; no catalytic influence was foun The flat flame is only stable within a fairly narro range of velocity; cusped flames are readily forme particularly with mixtures rather richer in oxyg than upper-limit mixtures. The flat-flame burner also applied to the determination of limits of co bustion. The lower limits are lower when determin in this manner compared with the standard tu method. The limit determinations can be carried o easily over a wide range of mixtures. The effect argon on the limits is consistent with the change specific heat of the mixture, but carbon dioxi appears to have a further effect.

536.46 : 539.

3544. Cyanogen flames and the dissociation ener of N_2. N. Thomas, A. G. Gaydon and L. Brewe *J. Chem. Phys.*, **20**, 369–74 (*March*, 1952).

The behaviour of cyanogen flames under a varie of conditions has been observed. Because of t relatively high stability of cyanogen, the behaviour considerably different from that of hydrocarb flames. Because of the high stability of the co

stion products, CO and N_2, the flame temperature n reach temperatures above 4 800°K. Thus the inogen-oxygen flame is the hottest natural flame own. Spectroscopic observations have been made both the reaction zone and the mantle of completely nbusted gases. Rotational and vibrational tem- rature measurements using the CN violet system ve indicated that the reaction zone is not in thermal uilibrium but that the mantle is in thermal equili- um. Comparison of the calculated flame tempera- es based on different heats of dissociation of N_2 h the observed mantle temperatures has fixed $_2 = 9{\cdot}764 \pm 0{\cdot}005$ eV and $D_{CN} = 8{\cdot}2 \pm$ eV. A.

536.46 : 541.126

45. Propagation of flame in a tube coated with an film. R. Loison. *C.R. Acad. Sci.* [*Paris*] **234,** 2–13 (*Jan.* 28, 1952) *In French.*

An electric spark started an explosion of a gaseous xture (25% O, 12·5% CH_4, 62·5% N, pressure g) in a metal pipe 4 m long, 25 cm dia. When 80–100 m long extension of this pipe, separated m the combustion chamber by a thin membrane klingerite, was coated with a sufficiently thick 3 mm) film of oil (lubricating oil D 15), a violent plosion occurred along the whole canalization: the essure wave attained rapidly the speed of 1 200 m/sec d a flame was visible at the opposite end of the pipe; the same time soot was formed. When the pro- rtion of oil was too small, the initial speed of the ve pressure gradually decreased. F. LACHMAN

536.48

46. On the lambda point of He^4–He^3 mixtures. Harasima. *J. Phys. Soc. Japan,* **6,** 271–4 (*July–g.,* 1951).

Theories so far proposed are mainly thermo- namical, and it seems that molecular theories have t yet appeared. The properties of the mixture of ^{4} particles which obey Bose–Einstein statistics and ^{3} particles which obey Fermi–Dirac statistics are re investigated. A.

536.48 : 534.21

47. On the theory of the propagation of sound in II. R. Kronig, A. Thellung and H. H. Wold- ngh. *Physica,* **18,** 21–32 (*Jan.,* 1952).

The considerations of a previous publication bstr. 1807 (1951)], based on the two-fluid model, e generalized to the case where the relaxation time the transformation of the two fluids into each ner may not be regarded as infinitely small and ere pressure has a noticeable influence on their uilibrium ratio. It is shown that under these cumstances a damping of first sound results in dition to that due to viscosity. From the experi- ntally determined attenuation, it follows that the axation time near the λ-point must be either less n about 10^{-12} or greater than about 10^{-4} sec. e theory of the temperature jump at a material undary for stationary heat flow is discussed on the ne basis. A.

536.521

48. The accuracy of the disappearing filament ometer. J. Euler and W. Schneider. *Z. angew. ys.,* **3,** 459–67 (*Dec.,* 1951) *In German.*

The theoretical basis is examined in detail. Trans- mission, colour and contrast characteristics were determined and it was concluded that the accuracy obtainable was better than that with which the temperature scale is defined in the range 1 500°–4 000°K for a working wavelength of 650 mμ. E. H. DOCK

536.531 : 621.3.011.22 : 621.316.8

3549. A design for standard resistance coils. C. R. Barber, A. Gridley and J. A. Hall. *J. Sci. Instrum.,* **29,** 65–9 (*March,* 1952).

A new method for the construction of resistance coils specially suitable for use in bridge construction is described. A strain-free spiral of Minalpha (manganin) wire is supported in grooves cut in a Perspex disk and hermetically sealed in N between Perspex cover-plates. Full details of the methods used in the construction and of the heat-treatment of the wire in order to obtain good stability are given. Coils of 1 000 Ω resistance have been made from about 42 m of 0·006 in wire contained in a disk of 7 in dia. and 0·2 in thickness: during the first few months after winding they have shown a rise of resistance of the order of 2 p.p.m./month. A.

THERMODYNAMICS 536.7/.8

536.7

3550. On the thermo-mechanical effect. J. E. Verschaffelt. *Bull. Acad. Roy. Belge Cl. Sci.,* **37,** 853–72 (*No.* 10, 1951) *In French.*

The author claims to give a more coherent exposition of the thermodynamic theory than that of de Groot, Jansen and Mazur [Abstr. 1809 (1951)]. His starting-point is a choice of forces and fluxes whose phenomenological equation is diagonal. He claims that the force conjugate to the flow of matter must include a term $\beta T \operatorname{grad}(1/T)$ where β is a third coefficient with whose help he can recover de Groot's formalism. [For his own justification of this procedure, see Abstr. 1720 (1949), 5793 (1950); for de Groot's criticisms see Abstr. 8718 (1950)]. In appendices (*a*) he criticizes de Groot's method of relating entropy production to fluctuations, and (*b*) he exhibits a linear transformation of flux and force variables which leaves entropy production invariant but destroys Onsager reciprocity, thus contradicting Meixner's theorem. [This transformation (which depends explicitly on the flow coefficients) leaves the entropy production invariant only when the forces and fluxes satisfy the phenomenological equation.] R. O. DAVIES

536.7

3551. The thermo-mechanics of osmosis. J. E. Verschaffelt. *Bull. Acad. Roy. Belge Cl. Sci.,* **37,** 950–9 (*No.* 11, 1951) *In French.*

Staverman [Abstr. 5158 (1951)] uses Onsager reciprocity to predict that the osmotic pressure will be less than its theoretical value whenever a membrane is partly permeable to the solute. This result is criticized here. Assuming that under isothermal conditions the unrestricted flow of the ith constituent is $J_i = -\alpha x_i \operatorname{grad} \mu_i$ (α independent of i) and using

the author's unorthodox method of analysis, the ordinary formula is shown to remain valid whatever the "efficiency" of the membrane. R. O. DAVIES

536.7

3552. On the electro-mechanical effect. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belge Cl. Sci.*, **37**, 960–9 (*No.* 11, 1951) *In French.*

By adding an electrical term to the assumption mentioned in Abstr. 3550 (1952) the author claims to treat the stationary state phenomena occurring when both an (electric) potential gradient and a pressure gradient are present. R. O. DAVIES

536.7 : 533.73

3553. Theory of transport phenomena based on the principle of superposition. J. E. VERSCHAFFELT. *Physica*, **18**, 43–62 (*Jan.*, 1952) *In French.*

A synthesis of the author's series of papers on the subject [e.g. Abstr. 4140, 5371 (1951)].

536.71

3554. A new thermal equation of state. I. J. HIMPAN. *Z. Phys.*, **131**, 17–27 (*No.* 1, 1951) *In German.*

A new equation of state is formed by replacing a/v^2 of Van der Waals equation by $a/Tv(v-c)$. The cubic equation may be used in the ordinary manner to express the constants in terms of the critical constants and a parameter $s(=RT_c/p_cv_c)$. The experimentally determined values of s are employed to investigate the Boyle temperature and pressure dependence of C_p. These results are compared with experimental values and those given by other equations of state. F. E. HOARE

536.71

3555. A new thermal equation of state. II. J. HIMPAN. *Z. Phys.*, **131**, 130–5 (*No.* 1, 1951) *In German.*

The equation of state obtained in Pt I is modified by writing $a/T^nv(v-c)$ instead of that previously used. The value of n is determined from the condition that as $p \to 0$ the correct value of the Boyle temperature shall be given. It is claimed that the resulting equation is considerably superior to other equations of state. F. E. HOARE

536.71

3556. A note on Dieterici's reduced equation of state. E. J. IRONS. Letter in *Amer. J. Phys.*, **20**, 114 (*Feb.*, 1952).

Attention is drawn to a common misquotation of the reduced equation of state. F. E. HOARE

536.71 : 541.183

3557. Van der Waals adsorption. H. FERIDUN. *Istanbul Univ. Fen. Fac. Mek., Ser. A*, **16**, 174–99 (*July*, 1951).

The combination of any equation of state reduced to two dimensions, and the Gibbs equation gives an adsorption equation. The equation derived from Van der Waals is shown to represent the adsorption of several gases with fair accuracy. An approximation to this equation, which can also be deduced from the Bertholts and Vohls equation, is shown to be identical to the Williams, Henry and Wilkins equation but allows both positive and negative constants. This equation then represents well the adsorption isotherms of Cl, Br and I on silica gel, though the three forms of isotherm are all different. A

536.7

3558. On the thermodynamics of irreversible processes. K. POPOFF. *Z. angew. Math. Phys.*, **3**, 42–5 (*No.* 1, 1952) *In French.*

Onsager and Casimir have established, on probability theory, that the coefficients L_{ik} of the phenomenological relations between the "flows" J_i and the "forces" X_i, $J_i = \sum_k L_{ik}X_k$ near the steady state [i.e. taking the expression of variation of entropy as $\Delta S = -(\sum_{i,k} g_{ik}x_ix_k)/2$] satisfy the equalities $L_{ik} = L_{ki}$. In this article it is shown that these are phenomenological consequences of Newton's mechanics in the more general case where ΔS is assumed as $\Delta S = \sum_i g_ix_i - (\sum_{i,k} g_{ik}x_ix_k)/2$. A

536.753 : 530.16

3559. Entropies of mixing in athermal mixtures of molecules of single and double size. M. L. MCGLASHAN. *Trans Faraday Soc.*, **47**, 1042–5 (*Oct.*, 1951).

The theoretical treatment of athermal mixtures of molecules each occupying two sites (dimers) and molecules each occupying one site (monomers) has been extended so as to exclude certain impossible configurations included in previous treatments. The effect of this correction on the entropy of mixing is a slightly closer agreement with Flory's formula. A

536.7

3560. Potential constants and thermodynamic properties of ozone. F. F. CLEVELAND AND M. J. KLEIN. Letter in *J. Chem. Phys.*, **20**, 337–8 (*Feb.*, 1952).

New calculations for the potential constants, taking $d = 1{\cdot}2775$ and $\alpha = 116{\cdot}75°$. A 3-constant potential function, as in Klein, Cleveland and Meister [Abstr. 8099 (1951)] is no longer possible. Values which seem reasonable are $f_{dd}/f_d = 0{\cdot}15$; $f_d = 4{\cdot}92$; $f_{dd} = 0{\cdot}739$; $f_\alpha = 1{\cdot}60$; $f_{d\alpha} = 0{\cdot}095$ md/A. The product of the 3 principal moments of inertia is increased by 28% and the free energy and entropy values accordingly by $0{\cdot}25$ cal deg.$^{-1}$M^{-1}. C. TURNER

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.2

537.21

3561. Polarization of a dielectric prism of square section placed in a uniform external field. V. A. KRAVTSOV. *Zh. Tekh. Fiz.*, **21**, 1402–11 (*No.* 11, 1951) *In Russian.*

Mathematical considerations show the field stress in a square prism to be approximately the same as in a cylinder. J. LUKASZEWICZ

537.22

3562. The Volta effect. R. BOURION. *J. Phys. Radium*, **12**, 930–40 (*Dec.*, 1951) *In French.*

Reviews the origins of work on the Volta effect

ntact potential difference between different metals) shows how it may be expected to arise in terms he modern theory of solids. The various methods ilable for measurement of contact potentials and rk functions are described, and the results obtained certain metals and semiconductors are critically cussed. The influence of surface structure on the ues determined and the anisotropy of the work ction as measured on single crystals are considered.

C. A. HOGARTH

537.221 : 551.594

53. Production of electric charges on water drops. W. B. GILL AND G. F. ALFREY. Letter in *Nature [Lond.]* **169**, 203–4 (*Feb.* 2, 1952).

n contrast to earlier work [Abstr. 5802 (1950)] no nsiderable contact potentials are found to be veloped at the water-ice interface during the ezing of dilute aqueous solutions. A tentative planation is offered of the observed large potentials veloped between water and ice. It is suggested that en a small water drop impinges on an ice particle rge negative charge is carried away by the rebound- water, a corresponding positive charge being left the outer ice layers. If melting occurs the arities may be reversed.

R. H. GOLDE

537.226.2

54. Ferroelectric properties of tantalates and bates of alkali metals. N. V. KOZHEVNIKOVA AND I. MEDOVOĬ. *Zh. Tekh. Fiz.*, **21**, 1383–7 (*No.* 11, 51) *In Russian.*

Experiments on heat-treated $NaTaO_3$, $KTaO_3$, NbO_3 and $KNbO_3$ show these to be not ferro- ctric in temperatures above 20°C, which does not nfirm results of Matthias presumably made on nocrystals [Abstr. 6988 (1949)]. It is possible se materials are ferroelectric at lower temperatures.

J. LUKASZEWICZ

537.226.2

55. Dielectric constants of various gases at 70 Mc. C. M. ZIEMAN. Letter in *J. Appl. Phys.*, 154 (*Jan.*, 1952).

Use was made of the principle that the resonance quency of a cavity depends upon the dielectric nstant and the permeability of the substance filling At S.T.P. the dielectric constants at 9 470 Mc/s tained by the method of electronic switching oted in terms of $(\varepsilon_0 - 1)\times 10^4$ are respectively: air, $5{\cdot}754 \pm 0{\cdot}021$; N_2, $5{\cdot}870 \pm 0{\cdot}020$; O_2, $320 \pm 0{\cdot}021$; and CO_2, $9{\cdot}875 \pm 0{\cdot}041$. When the paratus was converted into a microwave refracto- ter the values obtained were: dry air, $5{\cdot}74 \pm 0{\cdot}02$; $3{\cdot}55 \pm 0{\cdot}05$; and O_2, $5{\cdot}31 \pm 0{\cdot}03$.

R. S. READ

537.226.2

56. Photocontrolled low frequency dielectric dis- sion. J. R. MACDONALD. Letter in *Phys. Rev.*, 381 (*Jan.* 15, 1952).

Measurements are made of the dielectric dispersion additively coloured KBr and KI crystals irradiated their *F* bands. For KBr with $1{\cdot}4\times 10^{16}$ *F*-centres, permittivity at zero frequency is 5 in the dark as high as 500 under irradiation when the loss ows a maximum at 85 c/s applied field frequency.

G. F. J. GARLICK

537.226.2

3567. The dielectric constant of water vapor in the microwave region. G. BIRNBAUM AND S. K. CHATTERJEE. *J. Appl. Phys.*, **23**, 220–3 (*Feb.*, 1952).

The dielectric constant of water vapour was determined at 9 280 Mc/s by a cavity comparison method at 10 temperatures ranging from 32 to 103°C. In addition, observations were made at 24 800 Mc/s at the single temperature of 24·5°C. Although the vapour pressure was raised to within 10% of the saturation value at 24·5°C and 103°C, the variation of $(\varepsilon' - 1)/(\varepsilon' + 2)$ with pressure remained linear, contrary to observations made at radiofrequencies. These data are discussed in relation to the questions of association and adsorption of the vapour. The present results are in agreement with those obtained at radiofrequencies (sufficiently below saturation pressures) and do not show the dispersion reported in an early microwave experiment. Results obtained here and those obtained by others are used to determine mean values for the constants in the Debye equation: namely, $P = [3{\cdot}96 \pm 0{\cdot}32] + [(2{\cdot}077 \pm 0{\cdot}016)10^4/T]$. This gives a dipole moment of $(1{\cdot}846 \pm 0{\cdot}005)10^{-18}$ esu.

A.

537.226.2 : 536.424.1

3568. Phase transition in lead zirconate. E. SAWAGUCHI, G. SHIRANE AND Y. TAKAGI. *J. Phys. Soc. Japan*, **6**, 333–9 (*Sept.–Oct.*, 1951).

Detailed investigations on the dielectric and the thermal properties of $PbZrO_3$ have been made and compared with those of ferroelectric $BaTiO_3$. In contrast with barium titanate, volume change at the transition near 220°C has turned out to be expansion, being $\delta V/V = 2{\cdot}7\times 10^{-3}$, and a large amount of anomalous specific heat of *c.* 400 cal/mole have been found. Spontaneous polarization estimated from the hysteresis loop, and the effects of d.c. bias upon the permittivity and especially the shift of the transition point all imply that a spontaneous polarization may not exist below the Curie point. Since the dielectric constant, nevertheless, becomes extraordinarily high at the Curie point, it must be reasonable to say that lead zirconate belongs to a new type of dielectrics, say, antiferroelectrics. When the sample contains some additional materials, a narrow region of ferroelectric phase has been observed between antiferroelectric and paraelectric ones. The temperature range of this phase is sensitively affected by the amount and the species of the additional materials.

A.

537.226.2 : 536.424.1

3569. On the phase transition in barium-lead titanate. K. SUZUKI. *J. Phys. Soc. Japan*, **6**, 340–4 (*Sept.–Oct.*, 1951).

The temperature change in lattice parameters of solid solutions of barium titanate containing 10, 12, 20 and 25 mole % of lead titanate have been studied mainly by the X-ray method for the range from −130°C to 300°C. It was found that the lattice parameter-temperature curves for the solid solutions of 12 and 20% lead titanate have characteristic features as follows: (1) *a*-parameter-temperature curves show a considerable linearity from lower

temperatures up to the Curie point. (2) A large amount of discontinuity of *a*- and *c*-parameters takes place at the Curie point. (3) The superposition of cubic lines upon tetragonal lines is observed in a temperature range near the Curie point. The lattice volume calculated from tetragonal phase shows an abnormal contraction. These results are not explained by the Devonshire's theory in its original form, but they can be explained fairly well by using higher order approximation. A.

537.226.2 : 537.228 : 548.0

3570. Difference in dielectric constant between a free and a clamped KH_2PO_4 crystal. H. Baumgartner. *Helv. Phys. Acta*, **24**, 326–9 (*No.* 4, 1951) *In German.*

Measurements made using crystals with vacuum-evaporated silver electrodes give a straight line relation between the reciprocal of the dielectric constant and the temperature. The theory developed by Müller (to be published) to relate dielectric, piezo-electric and elastic constants of these crystals is fully verified. C. A. HOGARTH

537.226.2 : 548.7

3571. Effective fields in barium titanate. V. Kh. Kozlovskiĭ. *Zh. Tekh. Fiz.*, **21**, 1388–94 (*No.* 11, 1951) *In Russian.*

Formulae are derived for effective fields acting on ions of perovskite-type lattice under displacement. Results apply to barium titanate at temperatures below Curie point. J. LUKASZEWICZ

537.226.2 : 548.736.5

Structural changes in the ferroelectric transition of KH_2PO_4. *See Abstr.* 4026

537.226.2 : 621.3.011.5 : 621.315.612.4

3572. Dielectric properties of various grades of titanium dioxide. I. N. Belyaev, N. S. Novosiltsev, A. L. Khodakov and M. S. Shulman. *Zh. Tekh. Fiz.*, **21**, 547–51 (*No.* 5, 1951) *In Russian.*

Investigation of variation of loss angle and permittivity with temperature and frequency shows that variation depends upon the quantity of various impurities (CaO, MgO, Fe_2O_3, SiO_2 and traces of PbO and SnO_2) and on sintering. Tests results differ considerably from those obtained by Ksendzov [Abstr. 7227 (1950)]. J. LUKASZEWICZ

537.226.2 : 621.3.011.5 : 621.315.612.4

3573. Effects of firing temperature on the dielectric properties of barium-titanate ceramics. A. Kobayashi and H. Hino. *J. Phys. Soc. Japan*, **6**, 371–3 (*Sept.–Oct.*, 1951).

The slopes of tan δ for voltage and the initial tan δ of barium-titanate ceramics, which were fired at 3 different temperatures, has been measured in the temperature range from 150°C to −183°C. It was shown that below the Curie point the voltage region, where the values of initial tan δ did not change, were larger and the slopes of tan δ smaller, the higher the firing temperatures. Temperature dependence of the voltage region giving constant tan δ show three remarkable knicks corresponding to the phase changes of the crystals. A.

537.226.2 : 621.3.011.5 : 621.319.4 : 621.315.612

3574. Properties of powdered $BaTiO_3$. V. E. Dee and M. D. Earle. Letter in *Phys. Rev.*, **85**, 384 (*Jan.* 15, 1952).

A condenser with compressed powdered $BaTiO_3$ dielectric was charged to 45 V, then short-circuite for a few seconds, and finally connected through 300 kΩ resistance to a galvanometer: a residual di charge current was found which decayed much mo slowly than exponentially with time up to at lea 35 min with a value not very dependent on chargin time or on the metal used for the condenser plates. F. F. ROBERTS (

537.226

3575. The non-linearity of the relaxation of th dielectric polarization in solid dielectrics. G. Skanavi, A. I. Demeshina and S. V. Bogdanov *Zh. Eksper. Teor. Fiz.*, **21**, 684–92 (*No.* 6, 1951) *Russian.*

In the practical section figures show the decrea of dielectric constant, ε, with field strength up t 2 000 V/mm for various CaO/TiO_2 and SrO/TiO mixtures at 20°C and 50 c/s in polycrystalline sample The decrease in ε, e.g. from 1 200 to 780 wit $1{\cdot}25\ CaO\ .\ 100\ TiO_2$, is most marked at high TiO content and the lower fields. In $BaTiO_3$ ε increase with field but the magnitude of increase falls wit frequency at least to 10 kc/s. For $1{\cdot}25\ SrO\ .\ 100\ TiO$ the non-linearity decreases with higher frequencies an lower temperatures and changes sign at −89°C s that ε increases with field strength at −130°C. In thorough detailed theoretical treatment on a mod with ions passing through a barrier from one potenti well to another the exponential terms are expanded t the third power of the field and ε and loss tange given explicitly in terms of the barrier height, th distance between the wells, an internal field paramete frequency, temperature, field strength, etc., an limiting cases discussed. Qualitatively at hig temperatures, small relaxation times and low fr quencies ε should reduce with increasing field an increase under the opposite conditions of temperatur etc. D. H. WHIFFE

537.226.3 : 541.6

3576. Influence of orientation on dielectric losses polar polymers. G. P. Mikhaĭlov. *Zh. Tekh. Fiz* **21**, 1395–401 (*No.* 11, 1951) *In Russian.*

Strain or orientation of polymers causes maximu value of tan δ to occur at a higher temperature b with unchanged magnitude. It also causes a chan in the time of relaxation of dipole-elastic loss indicating an increase in activation energy and mol cular interaction. Time of relaxation correspondi to dipole-radical losses does not change. J. LUKASZEWIC

537.291 : 621.317.7

3577. An automatic tracer of electron trajectori and its application to the determination of the lines current in an electrolytic tank. J. Marvaud. *C. Acad. Sci.* [*Paris*] **234**, 45–7 (*Jan.* 2, 1952) *In Frenc*

The principle of the apparatus has been describe in Abstr. 1947 (1948) and a note is here given of t accuracy of the trajectory determined for the case

herical condenser (~0·5%). The simple double-nce modification required for current-line surements is described; this may readily be made balancing. A. J. KENNEDY

ECTRIC CONDUCTION . CURRENTS 537.3

537.311.1 : 539.11

8. The mean free path of electrons in metals. H. SONDHEIMER. *Adv. Phys.*, **1**, 1–42 (*Jan.*, 1952).

he electron theory of metals, developed by de, Lorentz and Sommerfeld, gives expressions various properties in terms of n (number of trons per unit volume) and l (mean free path of trons). The quantum mechanical analysis of the ion of electrons in a crystal lattice by Bloch and er authors has made it possible to estimate these ntities in certain cases. Of particular importance, vever, are experiments on small specimens at low peratures, such as the measurement of the con-tivity of thin films and wires in which the mean path is comparable with a linear dimension of the cimen. The behaviour of thin specimens placed magnetic field gives information on the momen-of the electrons at the surface of the Fermi dis-ution as well as the mean free path. A further effect is the anomalous skin effect in metals where mean free path is comparable with the depth of etration of a high frequency electric field. The ory of such effects is considered in detail, the lts of experimental work are reviewed and their tion to the modern theory of metals is discussed. M. R. HOPKINS

537.311.3

9. Proton conduction through solid alcohols due molecular rotation. Y. KAKIUCHI, H. KOMATSU S. KYOYA. *J. Phys. Soc. Japan*, **6**, 321–8 (*Sept.–*, 1951).

he anomalous electric conductivity in higher mal alcohols is often attributed to the proton nsfer accompanied by the rotation of molecules und their long axis. The direct experimental ification for the above idea is attempted, where lts are described in the following. The gas pro-ed as the result of the electric conduction is ntified spectroscopically with hydrogen, and its ount is found to coincide with the expected value, ming that the current is conducted solely by tons. The effect of the added long chain com-nds is observed and the result seems to be well erstood on the basis of the *proton-transfer-and-lecular-rotation* mechanism. A.

537.311.31

0. On the theory of electrical conductivities of novalent metals. A. B. BHATIA. *Proc. Phys. Soc. nd.*] *A*, **65**, 188–91 (*March*, 1952).

is shown that on the basis of the Bloch–Peierls–deen theory of conductivity, the use of $\theta_R \simeq \theta_D$ the Bloch–Grüneisen formula is a reasonable roximation in the temperature range $T > c.\ \theta_D$. At low temperatures $T \ll \theta_D$, however, $\theta_R = \theta_L$. This, it is shown, disagrees with experimental data much more than the *ad hoc* use of $\theta_R \simeq \theta_D$ in the Bloch–Grüneisen formula. A.

537.311.31 : 539.234

3581. On the law of variation, as a function of applied potential, of the electrical resistance of very thin metallic films. N. MOSTOVETCH, B. VODAR AND T. DUHAUTOIS. *C.R. Acad. Sci.* [*Paris*] **234**, 305–8 (*Jan.* 14, 1952) *In French.*

The saturation effect observed when fields of the order of 100 V/cm are applied is partly explained by the lowering of barriers between the grains due to Schottky effect. C. A. HOGARTH

537.311.31 : 539.234

3582. Variation of the resistivity of thin metal films as a function of the thickness and temperature. J. P. BOREL. *Helv. Phys. Acta*, **24**, 389–400 (*No.* 4, 1951) *In French.*

Experiments on the measurement of the conductivity of thin films of silver produced by evaporation are described; the thickness considered ranges from 2·5 to 20 millimicrons. The films are classed as being of three types—compact, porous and granular. The conductivity is considered to be affected by the crystallization of the metal, the modifications produced after deposition and the adsorption of gas. Curves are given showing how the conductivity varies with time after deposition of various thicknesses. M. R. HOPKINS

537.311.32

3583. On the electrical conduction mechanism in solid calcium carbide. X. HEITZER. Letter in *Naturwissenschaften*, **39**, 19 (*No.* 1, 1952) *In German.*

The electrical resistance of "technical" calcium carbide decreases with temperature. This is attributed to $^{12}C^{--}$ ions on the surface becoming atomic carbon when the thermal vibrations are high, together with some crystalline change. G. F. J. GARLICK

537.311.33

3584. On the conductivity and some other electrical properties of thoria under vacuum. G. MESNARD AND R. UZAN. *Vide*, **6**, 1052–62 (*July–Sept.*); 1091–7 (*Nov.*, 1951) *In French.*

The preparation of the thoria and the experimental tubes, consisting of two parallel W wires, 0·1 mm dia. and some tenths of mm apart, on which the thoria was deposited by electrophoresis, are briefly described. The methods used and the results, shown graphically, obtained for the measurement of the electrical resistance, both a.c. (50 c/s) and d.c., the thermoelectric e.m.f. and the thermal conductivity are discussed in some detail. Rectification effects and activation by the passage of the current were also investigated. The resistance measurements indicate a complex activation process and various theories and models to account for the experimental results are examined. S. WEINTROUB

537.311.33

3585. The physical properties of cuprous sulfides semiconductors. E. HIRAHARA. *J. Phys. Soc. Japan*, **6**, 422–7 (*Nov.–Dec.*, 1951).

Cu_2S has been observed to have two transition

points at about 110°c and 470°c respectively. The existence of the phase transition at 470°c has been confirmed experimentally by the measurements of electronic and ionic conductivity, thermal linear expansion, heat capacity, specific heat and thermo-electromotive force. It is suggested that Cu_2S has three polymorphic phases, namely α-phase (above 470°c), β-phase (470°c $\sim$ 110°c) and γ-phase (below 110°c). In the γ-phase, it behaves as a *P*-type semiconductor (sulphur excess), and its electrical conductivity increases exponentially with temperature. In the β-phase, ionic currents together with sharp decrease of electronic currents have been observed. On proceeding to the α-phase, the ionic currents abruptly disappear and electronic currents increase to larger values than in the γ-phase. The transition energy at 110°c has been observed to be $> 10\times$ (about 4·8 cal/g) larger than that at 470°c. In the β-phase, the anomalous thermo-electromotive force has been sometimes observed, and may be considered to be caused by the heterogeneous distribution of the movable copper ions. A.

537.311.33

3586. Properties of thermally produced acceptors in germanium. C. S. Fuller, H. C. Theuerer and W. van Roosbroek. Letter in *Phys. Rev.*, **85**, 678 (*Feb.* 15, 1952).

The fact that rapid cooling of *n*-type germanium heated to 800°c, converts it to *p*-type material, is explained on the basis of the diffusion of a *p–n* junction from the surface of the germanium into the interior. This explanation is tested in various ways for a number of specimens. C. A. Hogarth

537.311.33

3587. The drift mobility of electrons in silicon. J. R. Haynes and W. C. Westphal. Letter in *Phys. Rev.*, **85**, 680 (*Feb.* 15, 1952).

An average drift mobility of 1 210 cm²/volt-sec was obtained for electrons injected into single-crystal *p*-type silicon rods. Preliminary experiments on holes injected into *n*-type silicon suggest a ratio of 4·8 for the electron to hole drift mobility. P. T. Landsberg

537.311.33 : 537.32

3588. Electric and thermoelectric properties of partially reduced (blue) titanium dioxide. B. I. Boltaks, F. I. Vasenin and A. E. Salunina. *Zh. Tekh. Fiz.*, **21**, 532–46 (*No.* 5, 1951) *In Russian.*

Specific conductivity of TiO_2 increases with time of reduction. All samples show electronic conductivity; ionic was not detected. The temperature coefficient of conductivity is positive. Increase in reducing time of TiO_2 decreases the coefficient of thermal e.m.f. In slightly reduced samples this coefficient decreases—in strongly reduced samples it slowly increases—with increase in temperature. Hall effect was not measurable. Dissociation energy of current carriers follow a law known for other semiconductors determining temperature variation of conductivity. High effective mass of current carriers in TiO_2 explains the relatively high value of thermal e.m.f. and low conductivity. Effective mass of these current carriers in TiO_2 can several times exceed the mass of a free electron. J. Lukaszewicz

537.311.33 : 538.22

3589. Semiconductivity and diamagnetism of poly crystalline graphite and condensed ring systems. S Mrozowski. *Phys. Rev.*, **85**, 609–20 (*Feb.* 15, 1952)

The analysis of results obtained from studies of elec tric resistivity as a function of temperature, and sampl preparation, and of other available evidence, leads t a clarification of the electronic processes in the class o substances extending from condensed ring molecula solids to polycrystalline graphite. In all these solids the electric current flows preferentially along th benzene-ring planes. Scattering of electrons is due t thermal lattice vibrations and to the boundaries o molecular planes, where electrons pass throug potential barriers into the neighbouring crystallite These barriers are quite transparent in polycrystallin graphite and baked carbons, since the flow occur along the carbon-carbon bonds, but are quite opaqu in molecular solids where the barriers are due to th presence of foreign atoms attached at the periphe of the molecules. In contrast with the infinite graphit crystal, systems of benzene-rings of finite dimension possess a finite energy gap between the filled and th conduction bands, the energy gap steadily decreasin with increase of molecular size—from about 1 eV fo molecules several benzene rings wide, to 0·2–0·3 eV for systems 30–40 Å in diameter and to 0·05 eV fo graphite crystallites with diameters of the order o 1 000 Å. When in the process of carbonization foreign atoms are removed from peripheries, th carbon atoms left with free, unattached valencies pla a role of donors, that is, become a source of con duction (excess) electrons. The concentration of suc excess electrons increases as long as gases are drive out from the carbons, but starts decreasing as a resul of growth of crystallite size for samples treated t higher temperatures. The complete interpretation o the dependence of resistivity on temperature is base on a combination of these three factors: scattering concentration of the excess electrons and concentra tion of holes and electrons activated from the lowe band (over the energy gap). The anisotropic com ponent of the diamagnetism of condensed ring system has a twofold origin: (1) diamagnetism of the fille band (closed shell) of resonance (π) electrons, which i proportional to the number of benzene rings in molecule; and (2) the Landau diamagnetism of th free electrons and holes. The contribution of th Landau diamagnetism is by far the larger of the tw for graphite, but decreases fast with the crystallite siz and becomes negligible for molecules with diameter of 30 Å or below, due to an increase in the effectiv mass of carriers. A

537.311.33 : 538.63

3590. The electrical conductivity and isotherma Hall effect in cuprous sulfide semiconductor. H Hirahara. *J. Phys. Soc. Japan*, **6**, 428–37 (*Nov.–Dec* 1951).

The measurements were carried out on Cu_2S. I the stoichiometric specimens, the values of Hall con stant R are about $3 \sim 4\times10^9$ volt cm/gauss amp mobility μ and mean free path l are abou 12 [cm²/volt sec.], 9 [cm], respectively. These value of R, μ and l decrease in the β-phase. As compare with the stoichiometric specimens, the values of

l *l* in the sulphur excess specimens do not increase nuch as the conductivities. In the sulphur deficient cimens, on the other hand, the decrease of μ and *l* iot as remarkable as that of conductivities. These enomena may be considered to show that the im- rity scattering due to the free electrons and holes uces the values of μ and *l*. A.

537.311.33

91. The theory of contact of two semiconductors mixed conductivity. A. I. GUBANOV. *Zh. Eksper. or. Fiz.*, **21**, 721–30 (*No.* 6, 1951) *In Russian.*

The theory of the rectifying action is further de- oped mathematically, in continuation of the thor's previous work [Abstr. 7853, 8732 (1951)], ting into account the effect of contact potential ference, and of the thermal electron current, in the e of semiconductors, one of which conducts pre- minantly electronically, and the other predomi- ntly by means of holes. It is assumed that the semi- nductors are sufficiently thick to permit treatment the semiconductor-semiconductor contact inde- ndently of the semiconductor-metal contacts. The rrent through the barrier, as a function of the plied potential, is calculated. F. QUELON

537.311.33 : 621.314.634

92. Creep phenomena of selenium rectifiers. M. OMURA. *J. Phys. Soc. Japan*, **6**, 357–61 (*Sept.–Oct.*, 51).

Creep phenomena, i.e. initial decay of resistive ows, were observed, and polarization effects were und in the barrier layers at the same time. By serving discharge currents due to the above effect, aracteristics of the polarization were studied. As e polarization voltage increases with the duration of plication of the reverse voltage, the effective voltage rough the barrier layer decreases, resulting in the cay of the resistive flow. The characteristics of the cays were calculated on the standpoints of the larization effect and the non-uniform structure of e barrier layer. The relaxation time of the decay as discussed by considering that the polarization fect was due to ionic space charges in the barrier yer. A.

537.311.33 : 621.314.57

93. Barrier layer changes and statistical fluctua- ons in the three-electrode crystal [transistor]. H. F. ATARÉ. *Z. Phys.*, **131**, 82–97 (*No.* 1, 1951) *In erman.*

The origin of noise in crystal detectors and point- ntact transistors is considered and formulae for the ise voltage developed under various operating nditions are derived. The question of interaction tween the emitter and collector and the effect on ise figure are fully discussed. C. A. HOGARTH

537.312.5

94. Single contact lead telluride photocells. F. GIBSON. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 196–214 *March*, 1952).

In a recent paper [Abstr. 7895 (1951)] the photo- nductivity of PbS films was discussed in terms of a rrier mechanism. Large single crystals of PbTe ve now been grown and, with these, single barrier notocells can be prepared. The simplest barrier is formed at a metal-semiconductor contact. Such barriers, as exhibited in rectifiers, have been mainly studied. It is found that the photosensitivity and time constant of such cells is determined by the total current at the contact point, as expected from barrier theory. The variation in barrier height with temperature and time has also been determined. A.

537.312.5

3595. Lead sulphide rectifier photocells. A. F. GIBSON. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 214–16 (*March*, 1952).

Following the study of PbTe rectifier photocells described in the preceding abstract, similar properties have been found for PbS. A.

537.312.5

3596. Photoelectric investigations of naturally coloured rock salt, radiation-coloured fluorite and of vitreous borax. J. URBANEK. *Acta Phys. Austriaca*, **5**, 69–76 (*No.* 1, 1951) *In German.*

The minerals examined only show photoconductivity when coloured. In rock salt the photocurrents are of primary type but secondary currents predominate in fluorite. Experimental results give quantitative relations between current density, applied field and incident light intensity, and also the spectral response for the photoconductivity. G. F. J. GARLICK

537.312.5 : 535.215

3597. Spectral characteristics of photocathodes in the ultraviolet range down to 1 500 Å. V. SCHWETZOFF AND S. ROBIN. *C.R. Acad. Sci.* [*Paris*] **234**, 316–18 (*Jan.* 14, 1952) *In French.*

See also Abstr. 9481–2 (1951). Photocathodes containing Sb are very sensitive in the Schumann region, particularly Sb–Cs cathodes. Sb–Li cathodes have also been investigated and have been found to follow the general characteristics of the other alkali-antimony photocathodes with the exception that the properties of the Sb–Li cathode do not range in the ultraviolet according to the atomic weight of the Li. A Sb–K cathode yields higher sensitivity at the max. value. W. SUMMER

537.312.5 : 621.385.15 : 621.383

3598. Electron-multiplier photocell for the ultraviolet down to 1 450 Å. V. SCHWETZOFF, S. ROBIN AND B. VODAR. *C.R. Acad. Sci.* [*Paris*] **234**, 426–8 (*Jan.* 21, 1952).

An improvement on an earlier cell [Abstr. 8001 (1950)] has a cathode of AgO–Cs with a sensitivity of 24 μA/lumen (colour temperature of 2 550°K); the effective dark current at the cathode is 10^{-14} A/cm^2. Multiplication factor (12 stages) is 3×10^6. The window of thin blown silica gives a cut-off at 1 450 Å. The response curve to a hydrogen lamp shows maxima at 3 500 and 1 600 Å. G. F. LOTHIAN

537.312.62

3599. Remarks on Fröhlich's theory of superconductivity. M. R. SCHAFROTH. *Helv. Phys. Acta*, **24**, 645–66 (*No.* 6, 1951) *In German.*

The introduction of magnetically polarized matter into a metal permits consideration of infinitely extended superconductors. In such a model, a very simple mathematical criterion for the occurrence of superconductivity can be given. It is then shown

that the interaction between the conduction electrons and the lattice vibrations in a metal, if treated by perturbation methods, can never yield the London equation for the supercurrent in a magnetic field. The discrepancy with a result obtained by Fröhlich [Abstr. 2704 (1951)] stems from an erroneous choice of the expression for the current density. Thus, believing the basic idea of Fröhlich's theory [Abstr. 325 (1951)] to be true, other approximations have to be considered. A general expression for the diamagnetic susceptibility of a gas of free charged particles, valid in any statistics, is derived by a new method. A.

537.312.62

3600. The question of the superconductivity of binary alloys of bismuth. N. E. Alekseevskiĭ, N. B. Brandt and T. I. Kosina. *Zh. Eksperteor. Fiz.*, **21**, (*No.* 8, 1951) *In Russian.*

The following become superconducting at temperatures indicated (in °K): BiLi (2·47), BiNa (2·25), Bi_2K (3·58), Bi_3Ca (2·00), Bi_3Ni (4·06), BiNi (4·25), BiRh (2·06), Bi_2Rh (2·9), Bi_4Rh (3·4), Bi_2Pd (1·73); the following are not superconducting down to the temperatures indicated: $BiLi_3$ (1·43), $BiNa_3$ (1·39), Bi_2K_3 (3·58), BiK_3 (1·40), Bi_2Mg_3 (1·5), Bi_2Ca_3 (1·38), Bi_2Pt (1·47), Bi_3Ca (1·52). Some of these data have been published previously. D. SHOENBERG

537.312.62

3601. The formation of a boundary between normal-conducting and superconducting metal. M. P. Garfunkel and B. Serin. *Phys. Rev.*, **85**, 834–40 (*March* 1, 1952).

An experiment is described in which a superconducting sample is arranged so that part of it is in the normal state and part of it is superconducting. The boundary surface is thus a single, large area rather than the complicated boundaries that exist between normal and superconducting regions when a sample is in the intermediate state. A large difference is found between the magnetic field at which the superconducting-normal state transition occurs and the magnetic field at which the normal-state-superconducting transition occurs. These results are in agreement with the thermodynamic theory of the phase transition. The thermodynamic theory, coupled with an assumption about the nature of the surface energy between superconducting and normal metal, is used to show how the hysteresis determines the ratio of this surface energy to a characteristic dimension of the superconductor. A measure of this ratio is given in the temperature region between 3·37°K and 3·68°K for superconducting tin. A.

537.32 : 538.63

3602. The anomaly of transverse galvanomagnetic and thermomagnetic effects. H. Fieber, A. Nedoluha and K. M. Koch. *Z. Phys.*, **131**, 143–55 (*No.* 2, 1952) *In German.*

Gives an electron theoretical treatment of the Hall, Nernst, Ettingshausen and Righi–Leduc effects, with special reference to regularities in sign of the different coefficients for particular metals. There appears to be an error of sign in the definition of the coefficients P and Q. For an earlier discussion of the whole subject see Abstr. 2476 (1948). E. P. WOHLFARTH

537.32

3603. The variation of the thermal e.m.f.'s of thin metal foils with foil thickness. E. Justi, M. Kohler and G. Lautz. Note in *Naturwissenschaften*, **38**, 475–6 (*No.* 20, 1951) *In German.*

The absolute thermal e.m.f. (e) becomes dependent on the dimensions of a specimen as soon as these dimensions are comparable to the mean free path (λ) of the conduction electrons. An equation has been derived relating the change in e to λ and to the foil thickness. The e of thin Pb and Bi foils were determined relative to the e of Cu and the λ's were calculated from these results. Good agreement was obtained with determinations by other methods. A. J. KENNEDY

537.36 : 532.1

3604. Determinations of electrokinetic charge and potential by the sedimentation method. I. Silica in aqueous solutions of potassium chloride. C. I. Dulin and G. A. H. Elton. *J. Chem. Soc.* (1952) 286–9 (*Feb.*).

The sedimentation method for the determination of electrokinetic charges and potentials [Abstr. 3786 (1951)] is applied to the study of fused silica surfaces in dilute aqueous KCl solutions. The results obtained are in good agreement with those calculated from streaming potentials, confirming that the basic assumptions used in deriving the theory of the method are sound. Addition of small amounts of AgCl to the solutions produces a rise in the charge and a fall in the potential, indicating that the use of Ag–AgCl electrodes in electrokinetic experiments is not to be recommended. A.

ELECTRIC DISCHARGES 537.52

537.52 : 537.533.72

3605. Notes on a paper by Haigh and Smith. B. N. Klyarfeld. Note in *Zh. Eksper. Teor. Fiz.* **21**, 855 (*July*, 1951) *In Russian.*

See Abstr. 6514 (1950).

537.521.7

3606. New types of discharges in magnetic fields. K. Siebertz. *Acta Phys. Austriaca*, **5**, 134–47 (*No.* 1, 1951) *In German.*

This descriptive paper discusses the behaviour of discharge plasmas between electrodes whose common axis is along or perpendicular to the axis of a magnetic field. The effects are explicable, and contrary to the suggestions of Ehrenhaft and collaborators [Abstr. 335 (1951)]. J. D. CRAGGS

537.523.4

3607. A new effect observed in connexion with electrically "exploded" wires. W. M. Conn. Letter in *Nature* [*Lond.*] **169**, 150–1 (*Jan.* 26, 1952).

Describes observations of appreciable ionization detected by a Geiger counter, persisting up to 8 min after the vaporization of a Cu wire in a condensed discharge (1·9 mfd, 17·5 kV, 0·0080 cm wire dia.). J. D. CRAGGS

537.523.5 : 537.525.5

608. Arcs with and without cathode spots. W. Veizel and W. Thouret. *Z. Phys.*, **131**, 170–84 (*No.* 2, 1952) *In German.*

Developes a simple theory of electrode spot formation and discusses discharges in which electrode spots do and do not appear. For example, the higher cathode temperature observed when no cathode spots appear, and the sudden transition from arcs having electrode spots to those without electrode spots, are amongst the effects treated. J. D. CRAGGS

537.525.2 : 537.534.8

Secondary electron emission in vacuum breakdown. *See Abstr.* 3640

537.525.5 : 538.565

609. Resonant cavity measurements on a d.c. discharge. A. L. Cullen and K. W. H. Foulds. Letter in *Nature* [*Lond.*] **169**, 236–7 (*Feb.* 9, 1952).

Describes certain resonance effects produced in a cavity (H_{011} mode) containing a low pressure d.c. glg discharge, at frequencies of c, $2{\cdot}96\times10^9$ c/s. J. D. CRAGGS

537.525.8

610. Battery effect ["pile"] in a gas ionized with high frequency field. M. Chenot. *C.R. Acad. Sci. Paris*] **234**, 608–10 (*Feb.* 4, 1952) *In French.*

A note describing certain effects of h.f. discharges, such as the establishment of a p.d. between two plates in the ionized gas of a discharge excited with external electrodes. A brief explanation, in terms of spatial variation in space-charge densities, etc., is offered. See also Abstr. 2533 (1949). J. D. CRAGGS

537.525.8 : 621.387

611. A note on the temperature coefficients of running voltage of glow-discharge tubes. F. A. Benson and H. Bache. *J. Sci. Instrum.*, **29**, 25–6 (*Jan.*, 1952).

The temperature coefficients of running voltage for 4 different types of tube have been recorded as the ambient temperature was reduced below room temperature. This work has been carried out to determine whether the temperature coefficients are of opposite sign for deviations above and below room temperature. An attempt is made to explain the phenomena observed. A.

537.525.82

612. On the theory of stratification of the positive column of a gas discharge. I. P. Bazarov. *Zh. Eksper. Teor. Fiz.*, **21**, 711–16 (*No.* 6, 1951) *In Russian.*

The theory, taking account of wall influence and movement of ions, is developed. The existence, under certain conditions, of stratification in the vicinity of the anode, is predicted. This has recently been observed [Zaitsev (1950)], the experimental data agreeing satisfactorily with theory. F. QUELON

537.527.3 : 537.527.4

613. A study of the pre-breakdown currents in compressed air. A. Boulloud. Letter in *J. Phys. Radium*, **12**, 953–4 (*Dec.*, 1951) *In French.*

Discusses pre-breakdown currents, $> 10^{-10}$ A, observed in air at about 50 atmospheres, and due, it is suggested, to cold emission from the cathode augmented by space charge effects. J. D. CRAGGS

537.529

3614. Behaviour of electrons in crystalline insulators in high electric fields. W. Franz. Note in *Naturwissenschaften*, **39**, 18 (*No.* 1, 1952) *In German.*

The criteria for dielectric breakdown presented in other theories are considered and corrections applied to the estimated breakdown strengths from a consideration of pre-breakdown currents and distribution of conduction electrons. G. F. J. GARLICK

537.529 : 536.48

3615. The electrical conductivity and dielectric strength of thin glass membranes. G. Glaser. *Z. angew. Phys.*, **4**, 12–16 (*No.* 1, 1952) *In German.*

A study at low temperatures (120°K–300°K) shows that the effect of an external field F can be described by Poole's equation $\sigma = \sigma^* \exp[(\varepsilon - ckTF)/kT]$. The effective activation energy is thus decreased by the term $ckTF$ but electrical breakdown occurs before $\varepsilon - ckTF = 0$. At room temperature the field strength for zero activation energy is 14 MV/cm while electrical breakdown occurs at 4 MV/cm. Electrical breakdown (as opposed to thermal breakdown) is therefore not directly connected with conductivity. The dielectric strength is independent of specimen thickness down to 0·07 μ and it increases at lower temperatures. R. O. DAVIES

X-RAYS 537.531

537.531

3616. Wire-shaped anticathodes. J. Barraud. *C.R. Acad. Sci.* [*Paris*] **234**, 614–16 (*Feb.* 4, 1952) *In French.*

A fine wire, 25–50 μ diameter, supported in a beam of electrons on a water-cooled holder gave a very fine-focus X-ray source. Tungsten wires were satisfactory, but molybdenum and copper wires did not last long. A. R. STOKES

537.531 : 535.215.1 : 537.533.75

3617. The study of photoelectrons in nuclear track plates. J. M. Blum. *J. Phys. Radium*, **12**, 860–3 (*Nov.*, 1951) *In French.*

The spectral distribution of photoelectrons released in a nuclear track emulsion by monochromatic X-radiation has been investigated and the relative yield of electrons from the K and L levels of silver and bromine has been obtained. The range-energy relationship for electrons in Kodak NT2a and Ilford G5 nuclear track plates has been extended in the range 8 to 30 keV. A. C. COATES

537.531 : 535.33

3618. The energy distribution in the continuous X-ray spectrum between 1 and 2 kV. H. Neff. *Z. Phys.*, **131**, 1–9 (*No.* 1, 1951) *In German.*

The spectrum was investigated using a plane-grating vacuum spectrometer and a Geiger counter. The results are in agreement with Kulenkampff's formula $E_\nu d\nu = cZ(\nu_g - \nu)d\nu$. A. R. STOKES

537.531 : 535.33

3619. New forbidden lines in the L-spectrum of mercury. G. B. Deodhar and C. Mande. *J. Sci. Industr. Res.*, **11B**, 1–4 (*Jan.*, 1952).

A detailed study on the forbidden lines in the

L-emission spectrum of mercury has revealed the existence of 4 new quadrupole lines $\lambda\lambda$833·3, 1062·7, 1308·5 and 1371·8 X.U. corresponding to the transitions $L_IO_{IV,V}$, $L_{III}N_{II}$, $L_{III}M_{III}$ and $L_{III}M_{II}$ respectively, and 3 new non-quadrupole lines $\lambda\lambda$843·4, 1097·6 and 1136·3 X.U. corresponding to the transitions L_IO_I, L_IM_I and $L_{II}M_{II}$ respectively. A.

537.531 : 535.43

3620. Scattering from isotropic colloidal and macromolecular systems. G. OSTER AND D. P. RILEY. *Acta Cryst.*, **5**, 1–6 (*Jan.*, 1952).

The theory of scattering for various idealized models of colloidal particles and macromolecules is developed in order to explain the angular scattering from systems of such particles. The scattering intensity is calculated for independent particles of the form of solid spheres, spherical shells, periodic shells, and various aggregates of spheres; and the results are compared with the scattering by gases of atoms and molecules. The scattering by non-ideal systems of non-interacting and of repelling spheres is calculated, using ideas derived from theories of scattering by non-ideal gases and liquids. A.

537.531 : 535.43

3621. Further calculations of X-ray diffusion in an infinite medium. L. V. SPENCER AND F. STINSON. *Phys. Rev.*, **85**, 662–4 (*Feb.* 15, 1952).

The problem of X-ray diffusion in an infinite homogeneous medium can be solved numerically by a method of expansion into suitable polynomial systems. This method has already been applied to determine the spectrum of scattered radiation as a function of distance from the radiation source for several cases of interest. This note presents further numerical applications of the polynomial method. A.

537.531 : 535.43 : 539.185

3622. Geometrical optics and the theory of multiple small angle scattering. G. H. VINEYARD. *Phys. Rev.*, **85**, 633–6 (*Feb.* 15, 1952).

The theory of the small-angle scattering of X-rays or thermal neutrons by particles of matter, in the case of particles large enough to produce large phase shifts, is re-examined. A theory based entirely on geometrical optics has been frequently employed in the past, and it is pointed out that, in the case of a single particle, this treatment gives an incomplete account of the scattering. A Huygens' principle approximational method (which is known to duplicate the results of wave theory in the single-particle case), is applied to the many-particle case, and it is shown that, here, the theory based entirely on geometrical optics is justified. A.

537.531 : 535.822

3623. "X-ray microscope" employing Laue reflections. G. N. RAMACHANDRAN AND Y. T. THATHACHARI. *Curr. Sci.*, **20**, 314–15 (*Dec.*, 1951).

A mica plate is distorted to give a concave mirror of focal length 7·5 cm, and photographs of a wire mesh taken with this system are reproduced. Magnifications up to × 20 were obtained. Further possibilities of the method are discussed. See also abstract following. A. R. STOKES

537.531 : 535.822

3624. A new method of obtaining focused images with X-rays. G. N. RAMACHANDRAN. Letter in *Phys. Rev.*, **85**, 378–9 (*Jan.* 15, 1952).

The proposed method uses Laue reflection of general radiation at nearly normal incidence on a crystal plate distorted to give a concave spherical mirror. A. R. STOKES

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 537.58 : 548.7

Surface emission of electrons from crystals. *See Abstr.* 4013

537.533 : 621.384.62

3625. Heavy beam loading in linear electron accelerators. K. JOHNSEN. *Proc. Phys. Soc.* [*Lond.*] *B*, **64**, 1062–7 (*Dec.*, 1951).

The influence of the beam current on the length, the obtainable particle energy and the efficiency of a linear accelerator is considered. The beam loading is especially important if the accelerator waveguide has low losses. The efficiency, defined as the ratio of h.f. power transformed into kinetic energy to the total h.f. power fed to the accelerator, can have a high value, 70–80%, but the particle energy obtainable drops considerably with heavy beam loading. A.

537.533.72

3626. On the dioptrics of electrostatic electron-lenses. G. WENDT. *Z. angew. Phys.*, **3**, 219–25 (*No.* 6, 1951) *In German.*

The investigation of electron lenses is much simplified by transformation of the standard differential equation. The expression for the axial potential is written in the form $\Phi = \text{const} + f(z) = \text{const} + S$. It is then established that, for several common electrode arrangements, $dz = (1 - s^2)^n ds$, $\frac{1}{2} < n < \frac{3}{2}$. The transformed equation has solutions which are Riemann functions of the second order and are of a type studied by Heun. When the const. $= +1$, the differential equation becomes a hypergeometric equation. This case corresponds with a plane cathode and circular aperture, which is discussed in detail. A. H. W. BECK

537.533.72

3627. Velocity analysis with high resolving power, using a magnetic electron lens. F. LENZ. *Naturwissenschaften*, **38**, 524–5 (*No.* 22, 1951) *In German.*

In this method of making a velocity analysis the cathode is brought closer to the objective lens than one focal length so that a ring focus is obtained. A section of the ring is focused by the decentered projection lens on to the screen. The width of the resulting bright line serves as a measure of velocity range, which is calibrated by injecting an a.c. voltage on the beam. A resolving power of 5×10^{-5} has been obtained. A. H. W. BECK

537.533.72

3628. On the axial potential of a three-electrode lens. P. GRIVET AND M. BERNARD. Letter in *J. Phys. Radium*, **13**, 47–8 (*Jan.*, 1952) *In French.*

Calculation of the lens parameters is greatly simpli-

ed when Regenstrief's [Abstr. 8770 (1951)] expression r the axial potential is replaced by an empirical nction. R. S. PEASE

537.533.72

529. **Cardinal points of a new model of a [magnetic] ectron lens.** P. GRIVET. *C.R. Acad. Sci.* [*Paris*] 34, 73–5 (*Jan.* 2, 1952) *In French.*

Focal lengths and mid-focal distances for the eld $H = H_0$ sech (z/b) [Abstr. 1051 (1952)] are bulated, mostly to 1 in $\sim 10^3$, against ν, the order f the Legendre function in the ray equation. The al values are given for $\nu = 0{\cdot}1\ (0{\cdot}1)\ 1{\cdot}5$ and $2{\cdot}0$, ie virtual (i.e. asymptotic) for $\nu = 0{\cdot}1\ (0{\cdot}1)\ 0{\cdot}9$ nd $0{\cdot}95$. J. C. E. JENNINGS

537.533.72

530. **On certain methods of determining the field t the axis in electron optics.** F. BERTEIN. *C.R. Acad. ci.* [*Paris*] 234, 417–19 (*Jan.* 21, 1952) *In French.*

Discusses results which may be obtained by de-eloping the potential due to each individual electrode a series of Legendre polynomials and superposing ese potentials to obtain the overall result. A ystem of coaxial cylinders is used as an example. A. H. W. BECK

537.533.72

531. **Electron optical experiments.** C. FERT. *J. hys. Radium*, 13, 64A–70A (*Feb. Suppl.*, 1952) *In rench.*

A description of a simple apparatus comprising an djustable electron gun, various adjustable lenses and fluorescent screen. The apparatus can be used for emonstrations, and some illustrative photographs re shown.

537.533.72 : 621.385.833

532. **The magnetic electron microscope objective ns of lowest chromatic aberration.** G. LIEBMANN. *roc. Phys. Soc.* [*Lond.*] *B*, 65, 188–92 (*March*, 1952).

The shortest focal length f and smallest chromatic berration constant C_c of an objective lens is directly roportional to the square root of the (corrected) ccelerating voltage V_r and inversely proportional to e maximum magnetic field strength H_p in the arallel part of the pole piece gap. For given values V_r and H_p, both f and C_c fall monotonically with e relative pole-piece separation S/D, although the duction is insignificant for $S/D > 2$. For each ns geometry there exists an optimum set of lens mensions. A.

537.533.72 : 621.385.833

533. **The technique of electron microscopy and the w Siemens 100 kV electron microscope.** E. RUSKA. *emens Z.*, 26, 6–15 (*Jan.*, 1952) *In German.*

Details of the construction are given and brief ference is made to the capabilities of electron icroscopes. Three photographs relating to strepto-ycin are shown. H. J. H. STARKS

537.533.72

534. **Magnetic focusing with a prolate spheroidal ld—details of a β-spectrometer and magnet.** H. O. W. CHARDSON. *J. Sci. Instrum.*, 29, 93–5 (*March*, 52).

Constructional details are given of a prolate spheroidal field β-spectrometer and magnet. The ring-slit, which selects those rays from a source on the axis which contribute to the first focal ring, is provided with a mechanism which allows an adjustment of its radius *in vacuo*. A discussion is given of the dependence of magnetizing power consumption on the size of instrument and on the momentum focused. A.

537.533.74

3635. **A study of the back scattering of electrons as a function of their energy.** F. SUZOR AND G. CHARPAK. *J. Phys. Radium*, 13, 1–10 (*Jan.*, 1952) *In French.*

A radioactive source is placed on a thin plane foil of aluminium separating two semi-cylindrical Geiger counters, and the back scattering of β-rays through a solid angle of 2π is studied using sources of S^{35}, Co^{60}, Na^{22}, RaE, P^{32}. F. LLEWELLYN JONES

537.533.74

3636. **The nuclear scattering of 1-MeV electrons and positrons.** H. J. LIPKIN. *Phys. Rev.*, 85, 517–23 (*Feb.* 15, 1952).

The scattering of 1 MeV electrons and positrons by thin foils has been investigated from two points of view: (1) to compare the cross-section for elastic nuclear scattering of positrons with that of electrons, and (2) to look for evidence of inelastically scattered electrons which have suffered large energy losses. The first experiment is of interest because theory predicts a large difference between electron and positron scattering as a result of spin-orbit coupling, and thus involves the magnetic moment of the electron. The second experiment is of importance because there have been many conflicting reports on the existence of inelastic scattering whereas theoretically one expects almost no inelastic scattering. Electrons and positrons from artificially radioactive sources were energy-selected by a solenoidal spectrometer before being scattered by various foils. After being scattered, the particles entered a second, analyser, magnetic field and were then detected by a Geiger counter. To study inelastic scattering of electrons the analyser field was varied. To study the e^-/e^+ scattering ratio, various scatterers could be employed without changing the equipment in any way except to replace the electron source by a positron source. Thus the e^-/e^+ scattering ratio could be measured with greater accuracy than the scattering of either particle separately. The observed e^-/e^+ scattering ratio 2–3 is consistent with a rather rough theory which does not take into account screening. No inelastic scattering was found in foils of Cu, Al or Pt. A.

537.533.75 : 535.215.1 : 537.531

Range of photoelectrons in nuclear emulsions. *See Abstr.* 3617

537.534

3637. **The focusing principles of high energy particle accelerators. II. Magnetic field accelerators.** M. HOYAUX. *Atomics* [*Lond.*] 2, 310–19 (*Nov.*, 1951).

For Pt I, see Abstr. 5472 (1951). A summary of the theory of vertical, radial and phase focusing is given with its application to each type of accelerator. J. H. FREMLIN

537.534.74

3638. 240-MeV proton-deuteron scattering. R. D. SCHAMBERGER. *Phys. Rev.*, **85**, 424–6 (*Feb.* 1, 1952).

A scattering apparatus within the tank of the 130 in cyclotron has been used to investigate proton-deuteron scattering by measuring coincidences between the proton and deuteron in elastic scattering and the two protons in inelastic scattering. The incident beam has been measured by measuring the C^{11} β-activity produced in the heavy paraffin targets. The differential elastic scattering cross-section has been obtained from 20·5° to 100° for the proton scattering angle in the centre-of-mass system. That portion of the inelastic scattering which results in a low-energy neutron has been investigated. The differential cross-section for this quasi-proton-proton scattering has been obtained at 3 angles in the centre-of-mass system of the 2 protons. The cross-section, equal to about one half of the free proton-proton cross-section at 90°, decreases as the proton scattering angle decreases. Maximum energies for the low-energy neutron distribution have been obtained at laboratory neutron angles of 0°, 90° and 180° with respect to the incident proton direction for proton scattering angles of 40°, 67° and 90° in the p–p centre-of-mass system. A.

537.534.75

3639. On some approximate relations between the energy, the specific ionization and the range of high-energy particles. A. ROGOZINSKI. *J. Phys. Radium*, **12**, 955–6 (*Dec.*, 1951) *In French.*

Simple semi-empirical formulae based on tables of Smith [Abstr. 1232 (1947)] and Aron [Thesis, Berkeley (1951)]. W. J. SWIATECKI

537.534.8 : 537.525.2

3640. Secondary electron emission from metals under positive ion bombardment in high extractive fields. E. W. WEBSTER, R. J. VAN DE GRAAFF AND J. G. TRUMP. *J. Appl. Phys.*, **23**, 264–6 (*Feb.*, 1952).

In the further study of breakdown mechanisms in high vacuum, experiments show that secondary electron emission from metals under positive hydrogen ion bombardment is small and increases only slowly with the electric field strength at the bombarded surface. Although more significant emission may yet be found with the heavier ions obtained in an actual vacuum gap, the particle interchange component of the breakdown process appears to be quantitatively inadequate on the basis of present measured electron and positive ion emission coefficients. The possible importance of negative ion emission deserves consideration in the particle exchange process. A.

537.534.8 : 537.542

3641. Induced emission (from cathode) of secondary electrons by polyatomic ions, and ageing phenomena in self-quenching G.M. counters. E. BERETTA AND A. M. BIANCHI. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **11**, 352–6 (*Dec.*, 1951) *In Italian.*

A table of coefficients of secondary emission is given relative to various organic gases, obtained as described in a previous paper [Abstr. 1803 (1949)]. Various ageing phenomena are discussed. L. PINCHERLE

537.534.8 : 539.166

3642. Proton bremsstrahlung at 140 MeV. R. WILSON. *Phys. Rev.*, **85**, 563–9 (*Feb.* 15, 1952).

The high energy γ-rays arising from 140 MeV proton bombardment of several elements have been studied using a scintillation counter telescope to detect secondary electrons. The angular distribution is consistent with an approximately isotropic distribution in the centre-of-mass system if the bremsstrahlung is assumed to come from p–n collisions inside the nucleus. This is in disagreement with a phenomenological potential treatment of the p–n force or the scalar-meson theory. The form of the spectrum is found to be consistent with the dv/v shape and the dependence on Z much as would be expected from an opaque nucleus with only the neutron contributing to the bremsstrahlung. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542

3643. Method of obtaining tritium ion beams with low gas consumption. W. R. ARNOLD. Note in *Rev. Sci. Instrum.*, **23**, 97 (*Feb.*, 1952).

The efficiency of a Thoneman ion source, expressed as μA of H^+ per cm^3 of H_2 gas used per hour, can be increased if He gas (to about 98% of the total pressure) is mixed with the H_2 or T_2. 1 cm^3 T_2 with 49 cm^3 He would give a T^+ beam of 1 μA for 50 hr. Graphs of efficiency, etc., as a function of H_2/He gas composition, are given. J. D. CRAGGS

537.542

3644. External cathode Geiger–Müller counters with fillings having a low temperature coefficient. G. FAUNY, M. FAUNY AND M. SCHÉRER. Letter in *J. Phys. Radium*, **12**, 954–5 (*Dec.*, 1951) *In French.*

Experiments with various gas fillings, Cl/A/Ne and mixtures of methylal, alcohol or isobutane with argon, are briefly mentioned. J. D. CRAGGS

537.542

3645. A parallel counter for cosmic ray measurements. A. SUSZKIN. *Z. Phys.*, **131**, 234–43 (*No.* 2, 1952) *In German.*

The dependence of the sensitivity and the range of the operating potential for counting, on the composition of the gas filling, the pressure and the electrode separation was investigated. J. HUGHES

537.542

3646. Electron velocities in Geiger counter gas mixtures. A. STEVENSON. Note in *Rev. Sci. Instrum.*, **23**, 93 (*Feb.*, 1952).

Describes a simple method for measuring electron drift velocities and gives values for E/p, for argon/ether and argon/butane mixtures, between 0 and 8 V/cm/mm Hg. J. D. CRAGGS

537.542

3647. Coincidence time delays in Geiger counters. A. STEVENSON. Note in *Rev. Sci. Instrum.*, **23**, 93–4 (*Feb.*, 1952).

Describes a method for studying delays, in G.M.

unters, due to variations in avalanche transit time. ese times varied from about 4×10^{-8} sec to $^{-7}$ sec. Results are given graphically. J. D. CRAGGS

537.542

48. Short double coincidence resolving times for -M tubes. C. E. MANDEVILLE. Note in *Rev. Sci. strum.*, **23**, 94–5 (*Feb.*, 1952).

Includes comments on the letters reported in the eceding two abstracts and emphasizes that resolving nes $< 10^{-7}$ sec are obtainable without coincidence ss using argon-ether tubes having a dia. of 1·5 cm. J. D. CRAGGS

537.542

49. General observations on discharge lag in unters. W. E. RAMSEY. Note in *Rev. Sci. strum.*, **23**, 95–6 (*Feb.*, 1952).

A further discussion (see preceding abstracts) of ort lags in Geiger counters, showing that the aximum delay times are consistent with the easured electron drift velocities. J. D. CRAGGS

537.542

50. Delay times in G–M counters. W. C. PORTER ND W. E. RAMSEY. Note in *Rev. Sci. Instrum.*, **23**, 5–6 (*Feb.*, 1952).

Describes and presents further measurements of ncidence time delays in argon-ether filled counters. he delays varied from about $0\cdot5\times10^{-8}$ to 10^{-7} sec. J. D. CRAGGS

537.542

51. Fabrication and properties of Geiger counters led with bromine vapour and intended for β and γ ospecting. C. GIMENEZ AND J. LABEYRIE. Note in *uovo Cim.*, **9**, 169–83 (*Feb.*, 1952) *In French.*

Gives in some detail the method of construction nd some properties of a Ne–A–Br filled self-quench- g counter working at 350 V and suitable for use etween −70 and +125°c. Appendices summarize e discharge phenomena in halogen counters and scuss the choice of materials. F. R. HOLT

537.542 : 621.387.424

52. Toroidal Geiger counters. N. G. TROTT. *Sci. Instrum.*, **29**, 87–8 (*March*, 1952).

The construction and testing of two new forms of roidal Geiger counter are described. In one form e cathode consists of a set of parallel wires and in e other of a wire helix. The counters have satis- ctory characteristics when filled with self-quenching s mixtures. A brief account is given of experiments th two counters enclosed in the same vessel and erated in coincidence. A.

537.542 : 537.531

53. A monitor for measuring X-ray beam intensi- s. C. M. HARGREAVES, E. PRINCE AND W. A. OOSTER. *J. Sci. Instrum.*, **29**, 82–5 (*March*, 1952).

Measurements of the intensity of diffracted X-rays e usually expressed as a fraction of the intensity of e incident beam. Such measurements become fficult when fluctuations of the mains voltage and equency causes variations in the intensity of the incident X-ray beam. This problem is solved by the use of the present monitor in which the incident X-rays produce ionization in a short length of their normal path and the ions so produced are used to measure the intensity of the X-rays at the same time as they are being diffracted. The ionization current operates a Wheatstone bridge circuit and the indicating galvanometer operates a photocell system so that the steady rate of movement of the galvanometer is recorded. This is taken as the measure of the incident X-ray intensity and the accuracy of the measurement is about 1%. A.

537.542

3654. Differences between counting and non-counting diamonds. I. Counting properties and spectral transmission. G. P. FREEMAN AND H. A. VAN DER VELDEN. *Physica*, **18**, 1–8 (*Jan.*, 1952).

The comparison is given of 36 diamond specimens, selected on their spectral transmission at 2536 Å. The comparison includes the efficiency and the maximum value of charge pulses in response to α-particles, and transparency to ultraviolet wavelengths below 3000 Å. The counting property is shown to be a property of the crystal itself, a conclusion which is confirmed by experiments described in Pt II. The ultraviolet transparency is the same in practically all crystals. A.

537.542

3655. Differences between counting and non-counting diamonds. II. Birefringency and luminescence. G. P. FREEMAN AND H. A. VAN DER VELDEN. *Physica*, **18**, 9–19 (*Jan.*, 1952).

The luminescence and birefringence of 36 ultraviolet transparent diamonds, out of which 13 are counters, are investigated. There is no correlation between counting property and luminescence. It is shown, however, that there is a marked difference between birefringence patterns of counting and non-counting diamonds. The latter are generally much more pronounced, indicating that the counting property is better if fewer cracks are present. Using this as a criterion to eliminate non-counters—together with the criterion of transmission at 2536 Å—75% of the remaining crystals act as counters. Moreover, it appears that laminations in transparent diamonds (diamond II specimens) observed by Raman and Rendall and by Ramachandran are a consequence of the mosaic structure of such diamonds. A.

537.542 : 621.318.572

3656. A method of pulse integration using the binary scaling unit. F. M. GLASS AND G. S. HURST. *Rev. Sci. Instrum.*, **23**, 67–72 (*Feb.*, 1952).

In some cases it is desirable to determine the dose resulting from certain types of ionizing radiation by weighting the pulses produced in a proportional counter by their height. An instrument that automatically integrates pulses in such a fashion is described. The pulses actuate one or more of a series of discriminators which are biased at successively higher voltages. The discriminators are connected into successive stages of two binary scaling units in such a way that the total number of counts recorded is proportional to the height of the initial pulse. A.

537.542 : 621.318.572

3657. A new coincidence method. E. GATTI AND E. GERMAGNOLI. Letter in *Nuovo Cim.*, **9**, 189–90 (*Feb.*, 1952) *In Italian.*

The method is for very high resolutions. The signals coming from the detector R_1 are delayed by a delay line, then mixed with the undelayed signals coming from R_2. The amplified pairs of signals go directly to one of the branches of the coincidence circuit, and through a delay line, identical with the first, to the other branch. This method thus requires one single amplifier, and it is no longer necessary that the delay introduced by the amplifier should be constant. The number of spurious coincidences is, however, doubled. L. PINCHERLE

537.542 : 621.316.722.9

3658. A note on performance parameters of voltage stabilizers. J. J. GILVARRY AND D. F. RUTLAND. Letter in *Rev. Sci. Instrum.*, **22**, 1021–2 (*Dec.*, 1951).

The performance of voltage stabilizers depends on 12 characteristic parameters [Abstr. 7971 (1951)]. Analytical expressions are given, which greatly simplify the experimental determination of those 5 parameters, which depend on the difference between the variational input and output currents.

G. D. SIMS (R)

537.542 : 621.318.572

3659. A single channel pulse amplitude analyser for measurement of coincident pulses. R. WILSON. *J. Sci. Instrum.*, **29**, 70–2 (*March*, 1952).

An instrument is described which has been used to select events when a pulse of a definite amplitude is coincident in time with another pulse of a definite amplitude; both in the presence of pulses of other amplitudes. The instrument has been used in nuclear physics. A.

537.542

3660. The diffusion cloud chamber. A. J. BARNARD AND J. R. ATKINSON. *Nature* [*Lond.*] **169**, 170–3 (*Feb.* 2, 1952).

The performance of a small chamber working at atmospheric pressure, in which methyl alcohol vapour diffuses through air between 60°C and the temperature of dry ice, is discussed and illustrated. In particular, the best conditions with regard to the electrostatic control of background condensation has been examined in relation to the build-up of equilibrium conditions of ionization density in the upper part of the chamber (where condensation does not occur) when the clearing field is removed. It is concluded that, at the present stage of development, intermittent operation, in which periods of continuous sensitivity of some minutes are available, leads to optimum working conditions. J. G. WILSON

537.543 : 621.3.018.3 : 621.385.16.029.6

3661. Magnetron harmonics at millimeter wavelengths. J. A. KLEIN, J. H. N. LOUBSER, A. H. NETHERCOT, JR AND C. H. TOWNES. *Rev. Sci. Instrum.*, **23**, 78–82 (*Feb.*, 1952).

Under certain operating conditions, magnetrons emit harmonics of their fundamental frequency of oscillation. With the use of the generating, filtering and detecting equipment described here, harmonics as high as the tenth (1·25 mm wavelength) have been obtained from *K*-band tubes and the third (1·1 mm) from a 3·3 mm tube. The peak power at these shortest wavelengths is estimated as a few hundred microwatts, which is adequate for a variety of physical measurements. Data are given on the harmonic spectra of various tubes and tube types. A.

537.543 : 621.385.2

3662. Space charge and transit time considerations for planar diodes for relativistic velocities. H. F. IVEY. *J. Appl. Phys.*, **23**, 208–11 (*Feb.*, 1952).

The usual Child–Langmuir equation is extended to the case of relativistic velocities for a diode with parallel plane electrodes. The solutions obtained are valid for any value of the accelerating voltage. As the variation of mass with velocity becomes important, the exponent giving the dependence of current density on anode voltage becomes less than three-halves, and for very large values of accelerating potential approaches unity. The variation with anode voltage of the transit time, both for the space-charge-free case and for the space-charge-limited case, has been calculated. The potential distribution across the diode is also discussed. A.

537.543 : 621.3.014.1 : 621.385

3663. Space charge limited currents between inclined plane electrodes. H. F. IVEY. *J. Appl. Phys.*, **23**, 240–9 (*Feb.*, 1952).

The method of attack devised by Walker has been applied to the problem of current flow between inclined plane electrodes. It is assumed that the initial velocities of emission are negligible. Solutions for the potential distribution, the space charge characteristic ("perveance"), the particle trajectories and the transit time in such diodes under conditions of complete space-charge limitation are given. The trajectories and transit time have also been determined for the space-charge-free case. The results are presented in both graphical and tabular form. In most cases the solutions are given for angles between the electrodes as great as 180°. For an angle between the electrodes of approximately 118° the transit time in the space-charge-free case is equal to that for complete space-charge limitation. The effect of accidental electrode tilt on the perveance of a diode, which presumably has parallel electrodes, has also been investigated. A rectangular electrode whose width is 1·24 times the interelectrode spacing is relatively insensitive to tilt about a line passing through its centre and parallel to its side. A disk-shaped electrode is insensitive to tilt about any axis passing through its centre if its diameter is 1·42 times the interelectrode spacing. A

537.543 : 621.3.013 : 621.385.

3664. The electric field in diodes and the transit time of electrons as functions of current. P. L. COPELAND AND D. N. EGGENBERGER. *J. Appl. Phys.*, 23, 280–6 (*Feb.*, 1952).

Equations, applicable to all the most simple symmetries, are developed as approximate solutions of the related problems of potential distribution and transit time in diodes as functions of current. For the case of coaxial cylinders, calculations, based on these equations, have been made. Although these calculations fail to confirm Ivey's suggestion that th

o of the field at the cathode with any degree of ce-charge to that in the absence of space-charge is niversal function of the ratio of the actual current he space-charge-limited current, they suggest that function varies slowly as the geometry is changed. ıs small corrections to the function developed for allel planes suffice to give a solution of high uracy for any ratio of anode to cathode radius. ıctions, applicable to electrons moving between xial cylinders, are tabulated to facilitate calcula- ıs of off-cathode field, off-anode field, transit time l the potential distribution for any fraction of the ce-charge-limited current. A.

537.543 : 621.385.1.032.216

5. Space current changes in thermionic valves owing small pulses of current. J. R. TILLMAN. *c. Phys. Soc.* [*Lond.*] *B*, **64**, 1046–52 (*Dec.*, 1).

A train of regularly spaced rectangular pulses of tage, amplitude-modulated at a frequency f_m and plied to the control grid of a commercial valve rking conventionally, caused space-current changes up to 0·01 A/cm² from the oxide-coated cathode. unmodulated pulse train, interlacing the first with elay of t_d, sampled the anode current; the samples tained a component at the frequency f_m of low el. The component decayed as t_d increased, with me constant of about 1 msec. It was sometimes phase with the component obtained when $t_d = 0$, sometimes in antiphase. The magnitude and se were often dependent on the history of the ve. Thus an operation known to poison the ıode was usually followed, temporarily, by a large iphase component. An in-phase component otes an enhancement of emission following a itive pulse; an antiphase component denotes gue. There is evidence that the impedance at interface between cathode core and coating is not ponsible for the effects. The fatigue may well be gely a surface, rather than a bulk or matrix, effect. pears some relationship to effects reported else- ere with pulses involving current densities of A/cm². A.

537.543 : 621.385.3.029.6

6. Transit time oscillations in triodes. O. H. TCHLEY AND M. R. GAVIN. *Brit. J. Appl. Phys.*, 2–4 (*March*, 1952).

Oscillations which are critically dependent on de voltage have been obtained over a wavelength ge of 6–20 cm in disk-seal triodes. The oscillations ır when the cathode-grid transit time is about 5× the alternating period. They are closely logous to the negative resistance oscillations ained in diodes. A.

537.545 : 621.395.645

7. A wide-band electrometer amplifier. I. CHOWITCH AND J. J. ZAALBERG VAN ZELST. *Rev. Instrum.*, **23**, 73–5 (*Feb.*, 1952).

is shown that by appropriate feedback methods possible to construct a wide-band electrometer lifier with a stable flat-response characteristic. analysis the signal-to-noise ratio has been found e most favourable in the case where the mean frequency of the amplifier is low. Some practical values of the circuit are given. A.

IONIZATION . THERMIONICS 537.56/.58

537.565

3668. Migration velocity in an electric field of electrons in argon. L. COLLI AND U. FACCHINI. Letter in *Nuovo Cim.*, **8**, 891–2 (*Nov.*, 1951) *In Italian.*

The method used was the study of the time constant for building up of α-particle signals in a ionization chamber. Previous experiments were vitiated by the presence of impurities. The velocity of migration increases slowly and almost linearly with E/p (E = electric field in volt/cm; p = pressure in mm Hg), being about 0·4 cm/μsec for $E/p \simeq 1$.

L. PINCHERLE

537.568

3669. Interpretation of observed pressure-dependent recombination coefficients. L. B. LOEB AND W. B. KUNKEL. Letter in *Phys. Rev.*, **85**, 493–4 (*Feb.* 1, 1952).

Results of Biondi and Brown [Abstr. 4815 (1949); 2527 (1950)] on various well-developed cooled plasmas, and of Varnerin [Abstr. 365 (1952)] on hydrogen are discussed and accounted for. Three basic equations are given, whose application depends on which carrier density (e.g. electron or negative ion) is measured. A recombination coefficient-pressure curve analogous to Varnerin's results is obtained if two positive ions, possibly H_2^+ and H_4^+ or H_3^+, are assumed. F. R. HOLT

537.572

3670. Changes in work functions of vacuum distilled gold films. CHUNG FU YING AND H. E. FARNSWORTH. Letter in *Phys. Rev.*, **85**, 485–6 (*Feb.* 1, 1952).

The work function of a gold film, freshly prepared at room temperature by evaporation in high vacuum, is lower than that of clean polycrystalline bulk gold but increases to the latter on sufficient heating. Structural changes, rather than the influence of adsorbed gases, are suggested as the cause of this behaviour. H. P. MYERS

537.58 : 537.533 : 548.7

Surface emission of electrons from crystals. *See Abstr.* 4013

537.583 : 533.5

Thoria-coated cathode used in ionization gauge. *See Abstr.* 3362

537.583 : 621.385.032.216

3671. Space charge effect in the oxide cathode layer. T. SHINDO. *J. Phys. Soc. Japan*, **6**, 352–6 (*Sept.–Oct.*, 1951).

It was concluded theoretically that space charge may be formed in the oxide cathode layer near the surface, when electric field at the cathode surface is sufficiently strong for the diode to be regarded as operating in the Schottky region. The calculations are carried out for one-dimensional model and neglecting the interface layer, which exists usually between the base metal and the oxide coating. As

the result of this space charge, the slope of the Schottky plots are several times greater than that predicted by the Schottky theory for metal surfaces. This space charge may be responsible for the microsecond emission decay observed by Sproull and others. A.

537.583 : 621.385.1.032.2

3672. The investigation of electron tubes with the aid of radio-isotopes. J. Debiesse and G. Neyret. *Vide*, **6**, 1098–102 (*Nov.*, 1951) *In French.*

Useful tracer elements are Ba^{139}, Ba^{140}, Co^{60} and W^{187}. Ba getters irradiated with neutrons to produce the 139 isotope are used to study the distribution of Ba after gettering. Irradiated W filaments are used to study the diffusion of W into alumina (heaters), which is initially 10^7 times as great as the value given by Langmuir's evaporation formula. The most important uses of tracers are in the study of migration in the oxide cathode, which leads to the ratio $i_e/i_{ionic} = 40\,000$. The diminution of emission from radioactive wires [Abstr. 1939 (1950)] is mentioned. A. H. W. BECK (R)

537.585

3673. A thermal ion source for negative ions. H. Hintenberger. *Helv. Phys. Acta*, **24**, 307–9 (*No.* 4, 1951) *In German.*

COSMIC RAYS 537.591

537.591

3674. Counters using Cherenkov's radiation. P. Bassi. Letter in *Nuovo Cim.*, **8**, 807–9 (*Oct.*, 1951) *In Italian.*

Experimental arrangement and some results are described for a system of cosmic-ray particle counting. C. A. HOGARTH

537.591.1

3675. Ionization spectrum of particles of the soft and hard component of cosmic radiation. N. A. Dobrotin, Ya. I. Graevskaya, N. L. Grigorov, S. I. Nikolskiĭ and I. D. Rappoport. Transl. in *Guide Russ. Sci. Period. Lit., Brookhaven*, **4** (*No.* 11) 335–8 (*Nov.*, 1951).

Full translation of article abstracted in Abstr. 8813 (1951).

537.591.1 : 523.165

Generation of ultra-radiation in stellar electromagnetic fields. *See Abstr.* 3211

537.591.1 : 778.3

3676. On the identification of particles in nuclear track emulsions. L. van Rossum, R. Desprez and M. Jeannot. *J. Phys. Radium*, **12**, 840–7 (*Nov.*, 1951) *In French.*

Cosmic-ray particles have been identified by comparing the grain density and small angle scatter (measured as a function of the residual range) with the values obtained for protons. Proton exposures have been used to investigate the amount of latent image fading that takes place during a cosmic-ray exposure, and to determine development characteristics. The ratio of the masses of π- and μ-mesons has been measured by a grain-counting technique and value of $1{\cdot}3 \pm 0{\cdot}1$ has been obtained. A. C. COA

537.591.

3677. Frequency of meson showers. C. Terreau *Helv. Phys. Acta*, **24**, 551–86 (*No.* 5, 1951) *In Fren*

The development of a shower of mesons a nucleons within a single target nucleus is treat using the Heitler–Janossy collision postulate for t energy distribution in an inelastic nucleon-nucle collision. Shower fluctuations are calculated wh the energy transfer probability is a power of t fractional transfer, while the mean behaviour obtained from a more general relation. Show development from incident (π) mesons is also co sidered, on the assumption that these arise throu the recoil of nucleons in elastic collision. J. G. WILS

537.591.

3678. On a second, third and fourth maxim observed in Rossi's transition curve. L. Allegre and M. Abd. El-Wahab Khalil. Letter in *Nuo Cim.*, **8**, 1011–13 (*Dec.*, 1951) *In Italian.*

The second maximum was found under a thickness of 12·5–15 cm, the third under ~25, t fourth under ~37 cm. At these maxima showers small angle are about three times as frequent showers of large angle. L. PINCHER

537.591.

3679. Local showers from thin transition layers a "narrow" atmospheric showers. J. Hamelin. *J. Ph Radium*, **13**, 11–14 (*Jan.*, 1952) *In French.*

The effect of thin (~1 g cm^{-2}) screens placed o neighbouring counter trays was studied as a functi of distance between these trays, for extensive a "narrow" atmospheric showers, the former being d tinguished by the operation of a distant unshield counter tray. A strong transition effect was detec for "narrow" showers and none for the feeble con bution from extensive showers. Further experime to determine the nature of the agency producing transition increase of narrow showers are reported J. G. WILS

537.591

3680. Emulsion cloud-chamber study of a high ene interaction in the cosmic radiation. M. Kapl B. Peters and D. M. Ritson. *Phys. Rev.*, **85**, 90 (*March* 1, 1952).

A new technique is described for studying hi energy interactions utilizing photographic emulsi as detectors. A detailed study has been made w this technique of one very high-energy mixed show Evidence is obtained for the multicore structure the soft component at depths of several radiat lengths in this mixed shower, along with the existe of a finite lifetime for the decay of the neutral π-me into two photons of the order of 1×10^{-14} sec.

537.59

3681. Transition effect for neutron production lead. S. B. Treiman and W. Fonger. Letter *Phys. Rev.*, **85**, 364–5 (*Jan.* 15, 1952).

Neutron production rate from a $\frac{1}{2}''$ Pb produ embedded in paraffin and exposed to cosmic radiat decreased exponentially with the thickness of a

ber placed over the paraffin. A transition maxi- would have to occur within the first ½″ of Pb.
W. J. SWIATECKI

537.591.3

The absorption curve of the cosmic radiation stratosphere. M. SCHEIN AND V. H. YNGVE. *Rev.*, **85,** 607–8 (*Feb.* 15, 1952).

e absorption in lead of cosmic-ray particles has measured at an altitude of 5·7 cm Hg with to unattained accuracy. The absorption at this de is compared with the absorption at sea level. ound that the soft component shows an increase out a factor of 90. The hard component shows sorption length of about 220 grams per cm² of ery different from the sea-level absorption of sons. It is concluded that most of the pene- g particles at 5·7 cm Hg are nucleons. A.

537.591.5

The 27-day periodicities of the hard com- t of cosmic rays and the terrestrial magnetic at a time of minimum solar activity. H. GHERI. *turforsch*, **6a,** 775–80 (*Dec.*, 1951) *In German.*

first harmonic of the 27-day variation of tion measured under 10 cm Pb at 2 300 m has derived for 23 rotation periods during 1943–45. mplitude and phase of this wave is discussed ation to the variation of the terrestrial magnetic
J. G. WILSON

537.591.5 : 523.53

Increase of cosmic ray intensity in correlation neteoric activity on Nov. 6–7, 1951. J. CLAY, JONGEN AND A. J. DIJKER. *Proc. K. Ned. Wet. B,* **54,** 430–1 (*No.* 5, 1951).

simultaneous increase of intensity was found in lzation vessels under different shieldings of Fe, ding with a period of meteoric activity of the ds. A.

537.591.8

Ionizing power of cosmic ray particles at sea S. D. CHATTERJEE. *Canad. J. Phys.*, **29,** 04 (*Nov.*, 1951).

ng a proportional counter telescope arrangement, ments have been carried out at sea level to e the nature and ionizing power of particles in oft component of cosmic radiation and those ced under 1·8 cm and 20 cm of lead. The indicate a preponderance of relativistic elec- in the soft component and under 20 cm of lead. 1·8 cm of lead there is some disagreement the calculated pulse height distribution curve his can be attributed to the production of rs in the lead. These showers would obscure resence of a small number of particles of un- y high ionizing power, if such exist. A.

537.591.8

Electromagnetic cascades in photographic ons. J. E. HOOPER, D. T. KING AND A. H. ISH. *Canad. J. Phys.*, **29,** 545–56 (*Nov.*, 1951).

tographic emulsion techniques are described servation and identification of electromagnetic ses which occur in the soft component of the radiation. Several cascade showers are illustrated and measurements on these are discussed in the light of theoretical predictions. A.

537.591.8

3687. Observation of a heavy meson of type *K* in a nuclear photographic plate. J. CRUSSARD, C. MABBOUX, D. MORELLET, J. TREMBLEY AND A. ORKIN-LECOURTOIS. *C.R. Acad. Sci.* [*Paris*] **234,** 84–6 (*Jan.* 2, 1952) *In French.*

In a balloon flight to 3 500 m a 1 300 μ primary track disintegrating into a 20 000 μ track at 90° was recorded. From the scattering of the tracks the energy of the secondary is $\geqslant 155$ MeV, and the mass of the primary probably $\sim 1\,200\ m_e$.
W. J. SWIATECKI

537.591.8

3688. The possible effects of $\varkappa$-mesons in the cosmic radiation. S. HAYAKAWA. *Proc. Phys. Soc.* [*Lond.*] *A,* **65,** 215–19 (*March*, 1952).

The decay and nuclear interaction schemes of κ-mesons are discussed. A tentative interpretation is made of some anomalous interactions of penetrating particles observed recently below ground. Further possible experiments testing the hypotheses made are suggested. A.

537.591.8

3689. Mean free path of neutral penetrating shower-producing radiation. H. W. BOEHMER AND H. S. BRIDGE. *Phys. Rev.*, **85,** 863–7 (*March* 1, 1952).

The collision mean free path has been measured in C and in Pb for neutral particles capable of producing penetrating showers. Several types of events are selected with different multiplicities of particles in the penetrating shower. For the events with highest multiplicity the mean free path is 85 ± 12 g cm^{-2} in C, and 143 ± 30 g cm^{-2} in Pb. A.

537.591.8

3690. The emission of slow positive and negative mesons from nuclear disruptions produced by cosmic radiation. H. YAGODA. *Phys. Rev.*, **85,** 891–900 (*March* 1, 1952).

Microscopic examination of 76 cm³ of thick (300 to 1 800 microns) nuclear emulsion exposed in the stratosphere has revealed 168 events in which slow mesons are created and terminate their range in the recording medium. Basing the identification of sign on either π–μ decay or σ-star formation at the range terminus, 26 of the ejected particles were π^+ mesons and 145 π^-. The small value of the π^+/π^- ratio is attributed chiefly to the production of the ejected mesons by neutral radiation. The observational frequency of the ejected π^- mesons increases rapidly with star size and is approximately proportional to the square of the excitation energy of the parent star. In two events initiated by charged primaries several slow negative mesons were ejected as the wide-angle members of large showers of particles. In general, the energy of the slow mesons is between 0·3 and 40 MeV. Corrected for escape from the emulsion the average frequency of the π^- meson production is proportional to $E^{0.6}$ for $E \leqslant 8$ MeV and to $E^{2.3}$ for energies between 8 and 40 MeV. Comparison of the data on ejected mesons with that available on cyclotron mesons indicates

close similarity in the form of the secondary star spectra, the π^+/π^- ratio and the energy distribution of slow π^- mesons. A.

MAGNETISM 538

538.1 : 525.24 : 530.1

A fundamental theory of the magnetism of massive rotating bodies. *See Abstr.* 3261

538.11

3691. Some magnetic properties of metals. I. General introduction, and properties of large systems of electrons. R. B. DINGLE. *Proc. Roy. Soc. A*, **211**, 500–16 (*March* 20, 1952).

A general introduction surveying the problems to be examined in a series of papers is followed by a detailed treatment of the magnetic behaviour of a large system of electrons. The Schrödinger equation is solved on the assumption that the system is unbounded, and the modifications caused by the finite size of the system are then determined for the limiting case in which the system is much larger than the electronic orbits. An expression is then obtained for the density of states, and the free energy of the system found assuming that $kT < E_0$, where E_0 is the degeneracy parameter. The magnetic susceptibility, thermodynamic potential and specific heat are discussed for the two cases N constant and E_0 constant. Explicit formulae are given for the temperature-dependence of the field-independent term in the susceptibility. In the final section the corrections due to electron spin are introduced. A.

538.11

3692. Some magnetic properties of metals. II. The influence of collisions on the magnetic behaviour of large systems. R. B. DINGLE. *Proc. Roy. Soc. A*, **211**, 517–25 (*March* 20, 1952).

A discussion of the effect of collisions on the magnetic properties of a large system of free electrons shows that the non-periodic term in the susceptibility is hardly affected, but that the periodic terms are reduced in magnitude by a factor $\exp(-hp/\tau\beta H)$, where p is the harmonic considered, τ is the mean collision time, and $\beta = eh/2\pi mc$. A.

538.11

3693. Some magnetic properties of metals. III. Diamagnetic resonance. R. B. DINGLE. *Proc. Roy. Soc. A*, **212**, 38–47 (*April* 8, 1952).

It is shown that electromagnetic radiation incident on a large system of electrons moving in a constant magnetic field H in a metal is strongly absorbed near a frequency $\nu = eH/2\pi mc$, where m is the effective mass. The resonance absorption is found to be of the same order of magnitude as the absorption due to the skin effect. A.

538.11

3694. Some magnetic properties of metals. IV. Properties of small systems of electrons. R. B. DINGLE. *Proc. Roy. Soc. A*, **212**, 47–65 (*April* 8, 1952).

The first part of the paper consists of a calculation of the magnetic properties of a system of electrons contained within a cylinder of very small radius placed with its axis parallel to the field direction. Perturbation theory is used to find the energy levels and from these the number of occupied states in a two-dimensional system is determined by summation over the quantum numbers; the results are then generalized to the three-dimensional case. The expressions for the magnetic susceptibility, thermodynamic potential, and specific heat are found to contain a steady term which remains of significant magnitude at all temperatures, together with terms periodic in the field which are significant only at very low temperatures. The influence of electron spin on both steady and periodic terms is discussed. The second part consists of similar calculations for a small spherical system. A.

538.12 : 538.52 : 621.318.42

3695. A method of designing a compensated solenoid giving approximately uniform field. T. A. HEDDLE. *Brit. J. Appl. Phys.*, **3**, 95–7 (*March*, 1952).

A method for designing a solenoid with an number of compensating end coils to produce an approximately uniform magnetic field along a large portion of the solenoid length. The design of a solenoid with two end coils at each end is given in a numerical example and its estimated performance compared with experimental results. A.

538.12 : 539.152 : 621.316.731.076.

3696. Nuclear-resonance magnetic field control. H. A. THOMAS. *Electronics*, **25**, 114–18 (*Jan.*, 1952).

Previous methods of stabilizing magnetic fields have been indirect and did no more than regulate the exciting current. Measurements of fields or differences of field by search coil or bismuth spiral are insensitive and inaccurate. By utilizing the phenomenon of nuclear resonance it is possible to obtain stabilization factors of between 10^5 and 10^6 and to make absolute field measurements with accuracies approaching 0·0025%. The physical principle of the method is briefly described. Proton transition is detected in a small glass vial containing water and a small amount of ferric nitrate. The relative advantages of several kinds of resonance detector are discussed with reference both to the stabilization of fields and to their absolute measurement. Complete details are shown of a regulator used to control a 35 ton magnet. The error signal was used to control the field of the main generator and antihunt was obtained from an auxiliary winding giving a rate voltage. Because of the high gain of the system the rate signal had to be amplified by a single-stage floating d.c. amplifier. The effect of the rate voltage circuit was to increase the time constant of the magnet from its normal 8 sec to 17 min. The main generator supplied 300 A [illegible] with 0·5 A field was controlled by 4 type 807 valves in parallel.

S. C. DUNN

538.12

3697. On the realization of uniform static fields. F. BERTEIN. *C.R. Acad. Sci.* [*Paris*] **234**, 308–9 (*Jan.* 14, 1952) *In French.*

A magnetic field, already almost uniform, may be further improved by means of a star of 5 additional magnets of variable magnetization. L. PINCHER

538.22

8. The magnetic susceptibilities of platinum, dium and palladium from 20 to 290°K. F. E. ARE AND J. C. MATTHEWS. *Proc. Roy. Soc. A*, , 137–48 (*April* 8, 1952).

An apparatus is described which makes possible rapid determination of the temperature variation the magnetic susceptibilities of small solid speci- ns. The deflections of a beam of light passing ough a Sucksmith balance are recorded photo- aphically. The temperature of the specimen, asured by a Au–Co/Ag–Au thermocouple in ntact with it, is initially reduced to 20°K and flections are recorded at small intervals of tempera- e as the temperature of the specimen rises to 0°K. The whole temperature range can be covered 4 hr. The mean deviation of single measurements m the best smooth curve passing through them is s than 0·2% of the mass susceptibility of the ecimens. Measurements on three pure Pd specimens ow a maximum in the susceptibility/temperature rve at 80°K. The experimental results for Pt show change in the curvature of the susceptibility/tem- rature curve below 90°K, the susceptibility increasing ore rapidly as the temperature decreases. The perimental results for Rh show a regular increase of sceptibility with increase of temperature. The sults for Pd are discussed in relation to the collective ectron treatment of metals, and assuming a parabolic stribution of energy states in the *d*-band, estimates e made of the effective Fermi–Dirac degeneracy mperature θ_F, the number of holes per atom, q, nd the exchange interaction energy θ'. The estimated alues are $\theta_F = 1\,020°K$, $q = 0{\cdot}29$, $\theta' = 554{\cdot}0°K$. imilar estimates are made in the case of Pt, the alues being $\theta_F = 1\,750°K$, $q = 0{\cdot}25$, $\theta' = 770°K$. A.

538.221

699. New ferromagnetic materials with high oercivity, high permeability and low losses. C. UILLAUD. *J. Rech. Cent. Nat. Rech. Sci., No.* 17, 9–87 (1951) *In French.*

A review article. A brief description of theory is ollowed by an account of permanent magnet naterials, soft Fe–Si and Fe–Ni alloys and ferrites.

E. P. WOHLFARTH

538.221

700. Motion of a ferromagnetic domain wall in Fe_3O_4. J. K. GALT. *Phys. Rev.*, **85**, 664–9 (*Feb.* 15, 952).

Experiments have been made on a sample of Fe_3O_4 ut from a single crystal in such a way that its ferro- nagnetic domain pattern includes an individual lomain wall whose motion can be studied. This ample has a permeability which is high (about 000) at low frequencies and drops off rapidly above 000 cycles. A hysteresis loop and data on wall elocity v. applied field were also taken. The data re discussed in terms of recent developments in the heory of the ferromagnetic domain wall. It appears hat this theory explains the data satisfactorily, and hat in so using it some of the fundamental magnetic onstants of Fe_3O_4 are determined. Some insight nto domain wall motion in ferrites generally is also ained in this way. A.

538.221

3701. Ferrites. A. FAIRWEATHER, F. F. ROBERTS AND A. J. E. WELCH. *Rep. Phys. Soc. Progr. Phys.*, **15**, 142–72 (1952).

With d.c. electrical resistivities several orders of magnitude greater than those of the ferromagnetic metals, and magnetic saturation intensities in some cases less than one order of magnitude smaller, the ferrites gave promise of greater "effective permeability" and lower "eddy-current" loss in high-frequency magnetic fields. Attempts to realize these advantages have had limited success, but have led to a deeper understanding of the ferromagnetic and antiferromagnetic behaviour of non-metallic substances. In the present report, a description of the physical and chemical structure of the ferrites, and of their preparation, is followed by an outline of Néel's theory of ferrimagnetism, and of the Kramers–Anderson theory of superexchange spin coupling. Several possible mechanisms which may account for the observed rather steep fall of permeability with increase of frequency, and for the associated energy absorption, are then discussed. The dielectric properties of ferrites are also of interest in high-frequency applications. The observed very strong dispersion and absorption may be interpreted in terms of the inhomogeneous microphysical structure of the sintered material, which is known to be sensitive to the oxygen content and heat-treatment conditions. The very low-frequency dielectric absorption may be due to adsorbed moisture in the material. The semiconducting properties are briefly discussed. An extensive bibliography is included. A.

538.221

3702. Neutron diffraction investigation of the atomic magnetic moment orientation in the antiferromagnetic compound CrSb. A. I. SNOW. Letter in *Phys. Rev.*, **85**, 365 (*Jan.* 15, 1952).

In CrSb the magnetic unit cell is the same size as the chemical unit cell. Neighbouring Cr atoms (ignoring Sb atoms entirely) along the *c*-axis have antiparallel magnetic moments but for next nearest neighbours the magnetic moments are parallel. Co-planar Cr atoms in planes parallel to the (001) also have parallel magnetic moments. J. THEWLIS

538.221

3703. Investigation of the constant of [irreversible magnetic] viscosity over the whole hysteresis cycle. J.-C. BARBIER. *C.R. Acad. Sci.* [*Paris*] **234**, 415–17 (*Jan.* 21, 1952) *In French.*

The constant S_ν is defined by $\Delta I/\chi \ln(t_1/t_2)$ [Abstr. 4211 (1950), 6314 (1951)]. The values of χ, the differential irreversible susceptibility, and of S_ν were measured for various field strengths for a specimen of Alnico (S_ν close to 1·65) and for a specimen of oerstit. E. P. WOHLFARTH

538.221

3704. Relaxation effects in ferromagnetic resonance. N. BLOEMBERGEN AND R. W. DAMON. Letter in *Phys. Rev.*, **85**, 699 (*Feb.* 15, 1952).

Experiments on nickel ferrite crystals enabled the spin-lattice relaxation time to be measured. The imaginary part of the complex permeability and the component of the magnetization parallel to the static

field were measured as functions of the microwave field strength. The results are not in accordance with classical theory, and a possible explanation based on the spin wave model is advanced. E. P. WOHLFARTH

538.221

3705. Torque curves and other properties of permanent magnet alloys. K. HOSELITZ AND M. MCCAIG. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 229–35 (*March*, 1952).

Further investigations of Alcomax III and related alloys have been made using a torque magnetometer. Samples with both columnar and random crystals have been used. Torque curves have been obtained after various sequences of heat treatment designed to throw light on the changes that occur in these alloys, and the magnitude and direction of the magnetic field applied during cooling has been varied. A method of deriving 3 independent constants of crystal anisotropy without using single crystals has been devised. A.

538.221 : 538.66

3706. Ferromagnetic resonance in single crystals of cobalt–zinc ferrite. T. OKAMURA AND Y. KOJIMA. Letter in *Phys. Rev.*, **85**, 690 (*Feb.* 15, 1952).

Measurements between room temp. and the Curie point of the resonance field and line width were carried out with the static field parallel to the [100] and [110] directions respectively. Experiments were also performed on polycrystalline specimens. Kittel's formula enabled K and g to be determined as functions of temperature. E. P. WOHLFARTH

538.221 : 538.66

3707. Temperature dependence of the line half-width of ferromagnetic resonance in single crystals of zinc-manganese ferrite. T. OKAMURA, Y. KOJIMA AND Y. TORIZUKA. Letter in *Phys. Rev.*, **85**, 693 (*Feb.* 15, 1952).

Measurements were carried out between −200°C and 110°C with the static field parallel to the [100] and [110] directions respectively and also for polycrystalline specimens. A marked dependence of the line width/temperature curves on orientation is noted. E. P. WOHLFARTH

538.221

3708. Microwave resonance absorption in antiferromagnetic materials. L. R. MAXWELL. *Amer. J. Phys.*, **20**, 80–5 (*Feb.*, 1952).

Microwave resonance absorption in Cr_2O_3, MnO, MnF_2 and CoO above and below the paramagnetic-antiferromagnetic transition temperature is reviewed. The amount of the absorption decreases abruptly in lowering the temperature of the sample through its Curie temperature. The nature of the crystal structure changes associated with the changes in magnetic structure are given for comparison. With the exception of CoO, the alignment of magnetic ions to form the antiferromagnetic configuration results in a deformation along an axis perpendicular to sheets of magnetic ions having parallel spins. Similar results are reported for magnetite. A.

538.222

3709. Some reflections on the phenomena of magnetic resonance in the region of radiofrequencies. A. KASTLER. *Experientia*, **8**, 1–9 (*No.* 1, 1952) *In French.*

In a first part, it is shown that in certain cases irradiation with light will modify the intensity of r.f. resonance signals, and that such an effect is particularly to be expected at low temperature and with circularly polarized light. In a second part connections between ultrasonic waves and magnetic resonance are examined and attention is drawn to the fact that magnetic resonance in crystals at very low temperature acts as a generator of ultrasonic waves of high frequency, those waves being detectable by study of the angular distribution of light scattered by the crystal. Finally it is emphasized that investigation of nuclear quadrupole resonance in mono-crystals must reveal striking anisotropy and coherence effects and that the study of destruction of coherence by small magnetic fields provides a new method for measuring spin-spin relaxation time. A.

538.22

3710. Anisotropy in paramagnetic resonance absorption of picryl-*n*-amino carbazyl. V. W. COHEN C. KIKUCHI AND J. TURKEVICH. Letter in *Phys. Rev.*, **85**, 379–80 (*Jan.* 15, 1952).

The position of the resonance lines was found to vary over a region of 7 gauss upon rotation of the sample through 90°. This may be caused by molecular diamagnetism. W. J. SWIATECKI

538.222

3711. Recording of microwave paramagnetic resonance spectra. R. T. WEIDNER AND C. A. WHITMER *Rev. Sci. Instrum.*, **23**, 75–7 (*Feb.*, 1952).

The method provides a means of recording paramagnetic resonance spectra on the chart of a recording potentiometer. The recorder trace presents the microwave power reflected from a resonant cavity containing the paramagnetic salt as a function of magnet current. A modulation scheme automatically eliminates the influence of changes in the real part of the susceptibility. With a frequency of 9 375 Mc/s traces linear in magnetic field have been recorded over of a range of 6 000 oersteds; also, individual lines as narrow as one oersted have been recorded with an accuracy which permits a detailed line-shape analysis. Typical recorder traces are shown. A.

538.222

3712. Hyperfine structure in the paramagnetic resonance of the ion $(SO_3)_2NO^{--}$. G. E. PAKE, J. TOWNSEND AND S. I. WEISSMAN. Letter in *Phys. Rev.*, **85**, 682 (*Feb.* 15, 1952).

Three peaks were observed, separated by 36 Mc/s. It is likely that the structure is h.f., arising from an interaction between the magnetic moment of the odd electron and the N^{14} nucleus. The Breit–Rabi formulae for the Zeeman effect of a system consisting of an s-electron and a nucleus of spin 1 are consistent with the observations if the zero field h.f. splitting is 54 Mc/s. That this is approximately true was checked by means of paramagnetic resonance experiments in fields of the order of 10 oersted. L. PINCHERLE

538.222

3713. A contribution to the study of nuclear paramagnetism. M. SOUTIF. *Rev. Sci.* [*Paris*] **89**, 203–42 (*July–Aug.*, 1951) *In French.*

The fundamental ideas and experimental techniques of various workers are stated and their relative

rits for special purposes are discussed. A w form of photographic integration with good nal/noise ratio is obtained by using dy/dt as the nal of the x axis of an oscilloscope whose screen photographed during successive scans which cessarily superimpose despite small drifts of H. the results section it is shown that the increase of e width of the H resonance below the λ-point of H_4Cl near $-30°C$ is that to be expected for the set of rotation about a trigonal axis of the NH_4^+ n but does not fit with alternative proposals such as mpletely free rotation. D. H. WHIFFEN

538.222

3714. Proton relaxation in paramagnetic solutions. . L. CONGER AND P. W. SELWOOD. *J. Chem. Phys.*, 0, 383–7 (*March*, 1952).

Those paramagnetic ions, such as Fe^{+++}, Mn^{++} nd Gd^{+++}, which are in *S* spectroscopic states; and ose ions, such as Cr^{+++} and Cu^{++}, which are fectively in *S* states through complete quenching of e orbital component, have been shown to produce ciprocal proton relaxation times proportional to the quare of the magnetic moment. Those ions such as Co^{++}, Nd^{+++} and Dy^{+++}, with strong spin-orbital oupling, have been shown to be, in equivalent oncentration, about ten times less effective. A.

538.222

3715. The paramagnetism of cupric chloride in queous solution. P. BERTHIER, C. COURTY AND . GAUTHIER. *C.R. Acad. Sci.* [*Paris*] **234**, 604–6 *Feb.* 4, 1952) *In French.*

A continuation of previous work on copper salts n dilute solution [Abstr. 9598 (1951)]. The susceptibility was measured as a function of $CuCl_2$ concentration. The measurements give $p_B = 1{\cdot}94$ for the Cu^{++} ion. E. P. WOHLFARTH

538.222 : 548.523 : 541.67

Calculation of the direction of maximum susceptibility in a $CuSO_4$, $5H_2O$ crystal by the method of oriented crystalline nuclei. *See Abstr.* 3993

538.222 : 548.7 : 539.11

Matrix elements and operator equivalents connected with the magnetic properties of rare earth ions. *See Abstr.* 3765

538.224

3716. Magnetic properties of lanthanum-manganese alloys. A. SERRES. Letter in *J. Phys. Radium*, **13**, 46–7 (*Jan.*, 1952) *In French.*

Metallographic investigation and measurement of the paramagnetic susceptibility between room temp. and 500°C show that the two metals are completely insoluble. The susceptibilities are only weakly temperature dependent and obey an additivity law. E. P. WOHLFARTH

538.24

3717. The magnetization of high-coercivity ferromagnetic substances in weak fields. D. I. VOLKOV. *Dokl. Akad. Nauk SSSR*, **80**, 349–51 (*No.* 3, 1951) *In Russian.*

538.24

3718. Intrinsic magnetization in alloys. W. J. CARR, JR. *Phys. Rev.*, **85**, 590–4 (*Feb.* 15, 1952).

The intrinsic magnetization of alloys among the iron transition group of metals has been explained using a Heitler–London model for the 3*d* electrons. The magnetic moment associated with each atom is determined by the principle of maximum spin and the sign of the interaction between neighbouring pairs from the overlap of the wave functions. It is found that a large number of alloys derive their spontaneous magnetization from an antiparallel arrangement of atomic spins. A.

538.24 : 548.7

3719. The spontaneous magnetization of a two-dimensional Ising model. C. N. YANG. *Phys. Rev.*, **85**, 808–16 (*March* 1, 1952).

The spontaneous magnetization of a two-dimensional Ising model is calculated exactly. The result also gives the long-range order in the lattice. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.551 : 621.318.7 : 621.392.52

3720. Generalized ideal filters. L. A. ZADEH AND K. S. MILLER. *J. Appl. Phys.*, **23**, 223–8 (*Feb.*, 1950).

One of the basic concepts in the theory of electrical filters is that of an ideal filter. As commonly defined, an ideal filter is a network which passes without distortion all frequency components falling within a certain frequency range while rejecting all other frequency components. In the present paper a broader definition is formulated which extends the concept of ideal filter to both linear varying-parameter and non-linear types of systems. Briefly, a filter *N* is said to be ideal if it can extract a set of signals M from the sum of M and some other set N. A direct consequence of this definition is that any ideal filter *N* (linear or non-linear) is idempotent, that is, is equivalent to a tandem combination of two filters each of which is identical with *N*. The converse, however, is true only in the case of linear filters. The basic properties of ideal filters are investigated by the use of function space techniques. It is shown, in particular, that by employing linear ideal filters one can separate two (or more) simultaneously transmitted sets of signals which occupy overlapping frequency bands, provided only the sets in question span disjoint manifolds in the signal space. A.

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561 : 523.72

3721. The excitation of electron oscillations in a shock wave; applications to radioastronomy. J. F. DENISSE AND Y. ROCARD. *J. Phys. Radium*, **12**, 893–9 (*Dec.*, 1951) *In French.*

Some characteristics of a shock wave in a highly ionized medium are examined. The diffusion of electrons and light particles to the front of the wave cause a polarization of the medium which eventually

halts diffusion. The velocity distribution of the electrons is shown to depart radically from Maxwellian, and in the case of an intense wave may break up into separate velocity groups with different mean velocities. These conditions allow of the excitation of amplified plasma oscillations, and this mechanism is suggested as the origin of intense solar radio emissions. M. W. OVENDEN

538.563 : 535.568.1 : 621.396.11

3722. Observation of rotatory Hertzian conjugate anomalies. R. SERVANT AND P. LOUDETTE. *C.R. Acad. Sci.* [*Paris*] **233,** 1593–5 (*Dec.* 19, 1951) *In French.*

The authors refer to previous work [Abstr. 3651 (1951)] in which a Cotton effect in Hertzian waves was obtained using a flat monospiral helix in their Hertzian polarimeter [Abstr. 1946 (1951)]. A typical result is shown of recent work in which a long helix is used. Several active anomalous bands are obtained. H. G. JERRARD

538.565 : 523.72

3723. On the electromagnetic radiation produced by by collisions of an electron in a very highly ionized medium. B. KWAL. *J. Phys. Radium,* **13,** 35–8 (*Jan.*, 1952) *In French.*

The theory of this type of radiation is discussed and is applied to the case (which in recent years has become of interest) of radiation from ionized regions of interstellar space and from the solar corona.

P. M. DAVIDSON

538.565 : 621.3.017 : 621.396.611.4

3724. Mode conversion losses in a TE_{01} type cavity resonator with tilted end-plate. K. SHIMODA. *J. Phys. Soc. Japan,* **6,** 378–83 (*Sept.–Oct.*, 1951).

A cylindrical cavity resonator of TE_{013} mode was constructed and its Q-value was measured at the frequency of 3 075 Mc/s. It was found that the Q-value is reduced, when the end-plate of the cavity is slightly tilted. The optimum Q-value ($Q_0 = 7{\cdot}53 \times 10^4$) agrees well to that calculated from the d.c. conductivity of the wall material (copper). It may be considered that some other modes (TE_{11}, TE_{12} and TM_{11} modes) of waves are generated from the primary TE_{01} mode and they are lost as heat and radiation, when the end-plate is tilted. Thereby the resonance of TE_{01} mode is damped by mode conversion which is calculated assuming the deformation of the cavity wall is small. The calculated result agrees well to the observed Q-value of the cavity with tilted end-plate. A.

538.565 : 621.3.018.4 : 621.396.615.14

3725. A frequency standard for microwaves. R. FERRERO. *Ric. Sci.*, **21,** 2142–4 (*Dec.*, 1951) *In Italian.*

A frequency multiplier was constructed giving standard variable frequencies around 2 000, 3 000 and 10 000 Mc/s. The output power is a few milliwatt. L. PINCHERLE

538.565 : 621.317.761

3726. Application of resonance phenomena to the realization of a frequency meter of high sensitivity. J. LAGASSE AND R. LACOSTE. *C.R. Acad. Sci.* [*Paris*] **234,** 421–2 (*Jan.* 21, 1952) *In French.*

The frequency (mains supply) is multiplied to 400 c/s by means of a synchronous motor and alternator and is coupled to a resonant circuit. A scale sensitivity of 6 cm for 1 c/s could be increased to 15 cm. L. ESSEN

538.565 : 621.396.611.21

3727. Single response thickness-shear mode resonators using circular bevelled plates. R. BECHMANN. *J. Sci. Instrum.*, **29,** 73–6 (*March*, 1952).

It is important that piezoelectric crystals used in wave-filters should be free from unwanted responses in a sufficiently wide frequency range. This article discusses how this condition can be fulfilled by circular bevelled plates vibrating in high-frequency thickness modes. It also describes a special gap holder used for such plates and designed for use in oscillators with high-frequency stability. A.

538.565.5

3728. On some strictly integrable cases of electromagnetically-coupled oscillations in two cavity resonators. L. BREITENHUBER. *Acta Phys. Austriaca,* **5,** 45–68 (*No.* 1, 1951) *In German.*

Strict calculation of the coupled frequencies of certain configurations on the basis of the elliptically-cylindrical co-ordinate system. The eigenvalue equations resulting therefrom are, for the case of weak coupling, explicitly developed and compared with the existing approximate method. Z. F. WOJNAR

538.565.5

3729. A study of the coupling induced between two modes in a microwave cavity by a gas discharge in a magnetic field. R. W. OLTHUIS. *Univ. Microfilms Publ. No.* 2425, 146 *pp.* (1951).

Electro-magneto-ionic coupling is caused by the interaction of an electron gas with high-frequency electric fields in the presence of a magnetic field. The electric forces induce motion of the electrons and their movement in the presence of a magnetic field develops forces normal to their velocity. This causes a deflection from the original line of force and simultaneously produces currents which couple to other electric fields and result in an interchange of power. This phenomenon was studied under controlled conditions both analytically and experimentally. Power, 1 mW; gas pressure, less than 2·5 mm Hg; frequency, 3 000 Mc/s. The problem which is treated is the electro-magneto-ionic coupling between two resonant modes in a cavity. The coupling was observed by introducing power into one mode in the presence of a low-pressure electrical gas discharge in the cavity and a pervading magnetic field, and measuring the power coupled out to a load from the second mode. The coupling is a function of the electron concentration, the magnetic field strength, the load and the geometry. An equivalent circuit and theory are developed for a coupler that give good agreement with the experimental results. The effect of cyclotron resonance is to enhance greatly the coupling effect. The resonance as a function of magnetic flux density is broadened by increasing the electron concentration. The effect of high-frequency electron losses was observed and the magnitude of the loss factor measured using microwave methods. The losses increase with gas density and electron temperature. An associated microwave measurement also yielded the average electron concentration

he tube of gaseous discharge in the cavity. A dency toward spontaneous electron cyclotron onance supported by the steady electric field of plasma is observed at the proper magnetic flux sity. The effect appeared as a small resonance erimposed on the broader resonance curve of wer transferred *v.* magnetic flux density. Ionic illations were sometimes noticeable. The value the coupling phenomenon as a means of modu- ion of microwave power is studied and it is con- ded, chiefly because of a low-power limitation, t this phenomenon is not commercially valuable communication. MICROFILM ABSTRACTS

538.566

30. On the concept of group velocity. P. POINCE- T. *C.R. Acad. Sci.* [*Paris*] **234,** 599–602 (*Feb.* 4, 52) *In French.*

In a medium whose refractive index is defined by $- a^2/\omega^2)^{\frac{1}{2}}$ the concept of group velocity is valid, en at infinity. At finite distances, the wave front nd preceding signals disappear rapidly, becoming periodic in character, in contrast to the steady state gime which propagates rigorously with the group elocity. G. D. SIMS

538.566

731. On the diffraction of electric waves by a erfectly reflecting wedge. Y. NOMURA. *Sci. Rep. es. Inst. Tôhoku Univ. B,* **1–2,** 1–23 (*Jan.*, 1951).

The problem is solved for a wedge of arbitrary angle, sing contour integral solutions of the wave equation nd employing the method of steepest descents. The olution is presented in a form suitable for numerical alculation, and tables of diffracted field strength gainst distance, for both horizontally and vertically olarized sources are given for wedges of angles)° and 120°. Tables and graphs relating diffraction ngle, wedge angle and field strength are also ncluded. G. D. SIMS

538.566 : 621.317.34 : 621.396.11

3732. Diffraction measurements at 1·25 centi- meters. R. D. KODIS. *J. Appl. Phys.*, **23,** 249–55 (*Feb.*, 1952).

Measurements have been made, using an image plane technique, of microwave diffraction near obstacles whose characteristic dimension is com- parable to a wavelength (1·2668 cm). Detector, obstacle and source of radiation are mounted on one side of a horizontal 4 ft by 6 ft conducting plane, and the operator and all auxiliary apparatus are located on the other. Measured distributions of both the phase and amplitude of the electric field near long cylinders of brass and polystyrene were obtained, and for the conducting cylinders these are compared directly with the results of a suitably modified theory. The technique has been extended to diffraction by a semi-infinite conducting plane screen, and it was found in this case that considerable error is introduced by the point source. With the substitution of a line source the measurements are again in close agreement with the theory. A.

538.566 : 621.396.671 : 621.3.014.1

3733. On the current induced in a conducting ribbon by the incidence of a plane electromagnetic wave. E. B. MOULLIN AND F. M. PHILLIPS. *Instn Elect. Engrs Monogr. No.* 26, 14 *pp.* (1952) [To be published also in *Proc. Instn Elect. Engrs, Pt IV,* **99**].

A mathematical analysis of the scattering of a plane wave by an elliptic cylinder is carried out (Mathieu functions are involved), and the current density is computed, the results being exhibited graphically. The diffraction pattern is calculated and compared with those of Morse and Rubenstein [*Phys. Rev.*, **54,** 895 (1938)]. The surface field of the ribbon is investigated, and conditions are found in order that the field be constant over the major portion of the width of a wide ribbon. The case of a very narrow ribbon is also discussed. L. S. GODDARD (R)

538.566

3734. On the theory of the hollow-tube waves. E. LEDINEGG AND P. URBAN. *Acta Phys. Austriaca,* **5,** 1–11 (*No.* 1, 1951) *In German.*

The wave propagation in unbounded cylindrical hollow tubes being specified by plane *E*- or *H*-type waves, the integration problem is reduced to a scalar differential equation. The singularity of the Hertzian, or the Fitzgerald, vector combined with this reduction and the assumption of plane waves is discussed. It is shown that the plane waves represent a "complete" system, i.e. no further irregular fields that do not already belong to either *E*- or *H*-type can arise.

Z. F. WOJNAR

538.566 : 621.392.26

3735. On the propagation of electromagnetic waves in a conducting tube filled with an inhomogeneous dielectric. C. AGOSTINELLI. *Atti Accad. Sci. Torino, I,* **85,** 331–47 (1950–51) *In Italian.*

The field components are expressed in terms of the parameters of a double family of orthogonal cylinders. In the particular case of a tube of circular cross-section, the problem reduces to the integration of a 4th-order linear differential equation. L. PINCHERLE

538.566.2

3736. The determination of the fine structure of the dielectric constant in a slightly inhomogeneous layer by means of reflection experiments. G. ECKART. *C.R. Acad. Sci.* [*Paris*] **234,** 309–11 (*Jan.* 14, 1952) *In French.*

The method proposed in a previous paper [Abstr. 5609 (1951)] required an extremely high experimental accuracy. It is suggested that a method introduced by Bremmer [Abstr. 1099 (1950)], based on a variety of W.K.B. approximation, may instead be used.

L. PINCHERLE

538.566.2 : 551.578.4

3737. Some quantitative measurements of three-centimeter radar echoes from falling snow. R. C. LANGILLE AND R. S. THAIN. *Canad. J. Phys.*, **29,** 482–90 (*Nov.*, 1951).

In the winter of 1948–49 a series of measurements was made at Ottawa in an attempt to verify, by experiment, the theoretical computations of Ryde for the intensity of backscattering of 3 cm radio waves by snowflakes. The radiation backscattered from falling snow was measured, together with the actual mass of snow per cubic meter of atmosphere. Whenever possible the size distribution of the snowflakes

was determined. Owing to the small number of snowstorms studied, firm conclusions cannot be drawn. However, the results obtained are in agreement with those predicted by Ryde, and provide useful practical information. A.

538.566.2 : 621.396.11

3738. On the propagation of electromagnetic waves from land to sea and conversely. I. P. HÖLLER. *Z. angew. Phys.*, **3**, 424–32 (*No.* 11, 1951) *In German.*

Approximate analysis of the influence of the transition in the conductivity σ and the dielectric constant ε, at the boundary of land and sea, on the propagation of the e.m. waves due to a vertical dipole transmitter assuming that the latter lies high over the earth's surface and the distance between coast line and transmitter/receiver is large. Z. F. WOJNAR

538.566.2 : 621.396.671 : 621.396.11

3739. On the propagation of electric waves from a horizontal dipole over the surface of the earth sphere. Y. NOMURA. *Sci. Rep. Res. Inst. Tôhoku Univ. B*, **1–2**, 25–49 (*Jan.*, 1951).

The cases of both electric and magnetic dipoles are treated using substantially the methods of Van der Pol and Bremmer. It is shown that the field of a horizontal dipole can be derived from that of a similarly situated vertical one. In the directly illuminated region, it is convenient to use a geometric optical approximation rather than a wave method, the field being expressed in terms of a direct and a reflected ray. The latter is the product of the incident ray and the reflection coefficient multiplied by a divergence factor, which is near to unity. G. D. SIMS

538.566.3

3740. The application of the Appleton–Hartree formula to the determination of the phase path of an electromagnetic wave in the ionosphere. E. ARGENCE. *C.R. Acad. Sci.* [*Paris*] **234**, 456–8 (*Jan.* 21, 1952) *In French.*

Continuation of earlier papers [Abstr. 8379 (1951) and 423 (1952)]. A direct method of determining phase paths from the Appleton–Hartree formula is outlined. W. J. G. BEYNON

538.566.3

3741. An improved method for the calculation of the field-strength of waves reflected by the ionosphere. K. BIBL, K. RAWER AND E. THEISSEN. Letter in *Nature* [*Lond.*] **169**, 147–8 (*Jan.* 26, 1952).

Formulae are given for calculating the limiting frequency reflected at oblique incidence by the *E*-layer, consideration being given to the influence of geometrical optics during refraction, to *D*-region absorption and to selective absorption in the *E*-region. W. J. G. BEYNON

538.566.3 : 621.396.11

3742. Ionospheric interaction in disturbed conditions. D. A. BELL. *Proc. Phys. Soc.* [*Lond.*] *B*, **64**, 1053–62 (*Dec.*, 1951).

Measurements of ionospheric interaction depend on special radio transmissions which are only available on a limited number of occasions, and only on some of these occasions are ionospheric conditions steady enough for direct comparison between experiment and theory. This paper describes the use of averaging methods to extract some information from observations made when conditions are not steady. The results confirm the existence of a "low-frequency anomaly" observed by Huxley, but show no excessional interaction for a variation of the frequency of the disturbing wave around the nominal gyromagnetic resonance frequency.

538.566.3 : 621.396.1

3743. The oblique reflection of long wireless waves from the ionosphere at places where the earth's magnetic field is regarded as vertical. J. HEADING AND R. T. P. WHIPPLE. *Philos. Trans A*, **244**, 469–503 (*No.* 883, 1952).

The calculation of reflection coefficients for ionospheric wireless waves incident obliquely on the ionosphere requires an exact solution of the differential equations governing the propagation of electromagnetic waves in the ionosphere. Equations are developed for the electromagnetic field in a horizontally stratified medium of varying electron density, the presence of a vertical external magnetic field and also the collision frequency of the electrons with neutral molecules being taken into account. Provided certain inequalities hold amongst these ionospheric characteristics, the ionosphere splits up effectively into two regions, in each of which the differential equations of wave propagation approximate to simpler forms. If a model ionosphere is chosen in which the ionization density increases exponentially with height, and the collision frequency is assumed constant over the range of height responsible for reflection, the equations for the two regions can be solved exactly. The solution for the lower region is expressed in terms of hypergeometric functions, and that for the upper region in terms of generalized confluent hypergeometric functions. Exact expressions in terms of factorial functions can then be deduced for the reflection coefficients of both regions separately. Moreover, these coefficients can be combined, with due allowance for the path difference between the two regions, to give the overall reflection coefficients for the effect of the ionosphere as a whole on an incident wave. A suitable definition is given for the apparent height of reflection in terms of the phase of the reflected wave. The results of the theory are illustrated in graphical form for a particular model ionosphere approximating to the "tail" of a Chapman region, and a brief comparison with experimental observations concludes the paper. A.

538.569

3744. Note on the limiting frequency in dielectric slabs. H. OTT. *Z. angew. Phys.*, **3**, 456–8 (*No.* 12, 1951) *In German.*

It is shown how to determine the existence of the lower frequency limit in dielectric slabs using Fresnel equations. Z. F. WOJNAR

538.569 : 537.56

3745. Interaction of travelling magnetic fields with ionized gases. P. C. THONEMANN, W. T. COWHIG AND P. A. DAVENPORT. Letter in *Nature* [*Lond.*] **169**, 34–5 (*Jan.* 5, 1952).

Large direct currents are produced when an ionized gas is confined in a toroidal vacuum vessel and an

n. wave is propagated in the direction of the cular axis of the torus. The magnetic field associated with the wave was used to accelerate electrons the direction of propagation. Z. F. WOJNAR

538.569.3 : 621.365.54

746. Low powered induction heater for laboratory ie. R. L. SHIPP. *Rev. Sci. Instrum.*, **23**, 91–2 (*Feb.*, 952).

Certain laboratory processes require low-powered f. heating with fine, continuous control. A light-eight low-powered induction heater which is apable of delivering about 20 W of power into a oad 12 ft from the heater with fair efficiency was eveloped to meet this need. A.

MAGNETIC EFFECTS 538.6

538.61 : 621.392.2

3747. Correlation of the Faraday and Kerr magneto-optical effects in transmission-line terms. C. H. UHRS. *Proc. Inst. Radio Engrs*, **40**, 76–8 (*Jan.*, 1952).

The subject effects follow immediately from the assumption of the inequality of the two sets of Maxwell's material constants, one set for right-handed circularly polarized waves and the other for left-handed circularly polarized waves. The Faraday magneto-optical effect is derived from phase considerations, and the Kerr magneto-optical effect is derived from impedance considerations. A.

538.613

3748. On the Faraday effect in paramagnetic substances in the microwave region. A. GOZZINI. *Nuovo Cim.*, **8**, 928–35 (*Dec.*, 1951) *In Italian.*

Measurements have been made of the Faraday effect on paramagnetic salts, at 3·2 cm wavelength. The Verdet's constant is found to change sign through the paramagnetic resonance band. A description of the experimental apparatus is given. The method proves to be particularly suitable for a simple determination of the *g* factor. A.

538.614

3749. Magneto-optic rotation in birefringent media—application of the Poincaré sphere. G. N. RAMACHANDRAN AND S. RAMASESHAN. *J. Opt. Soc. Amer.*, **42**, 49–56 (*Jan.*, 1952).

It is pointed out that the concept of the Poincaré sphere appreciably simplifies the mathematical treatment of phenomena accompanying the passage of polarized light through a medium which exhibits birefringence, optical activity or both simultaneously. This is exemplified by using the Poincaré sphere to evolve techniques which could be used for determining the true Faraday rotation in the presence of birefringence. When birefringence is present, measurements made with the half-shade at the polarizer and analyser ends are not equivalent. In either arrangement, the errors introduced as a result of birefringence are largely reduced by taking the mean of two measurements for opposite directions of the field. Formulae are also derived by which the magnitudes of the error can be calculated for the particular experimental set up, knowing the value of the birefringence. In certain cases, even this need not be known, and the true rotation can be determined purely from measurements of the apparent rotations for two different azimuths of the incident plane of polarization. A.

538.632

3750. Measurements of the Hall effect in zinc oxide. K. INTEMANN AND F. STÖCKMANN. *Z. Phys.*, **131**, 10–16 (*No.* 1, 1951) *In German.*

Measurements of Hall effect and electrical conductivity of various evaporated ZnO layers were carried out and yielded mobility values of about 10 cm^2/volt sec. Photo-conductivity measurements yielded a similar value. The results are used in a discussion of the conduction mechanism for ZnO with excess Zn in (*a*) interstitial positions, (*b*) substitutional positions, and (*c*) a mixture of (*a*) and (*b*). C. A. HOGARTH

538.632

3751. Hall effect and ponderomotive force in simple metals. N. ROSTOKER. *Amer. J. Phys.*, **20**, 100–7 (*Feb.*, 1952).

The Bloch–Sommerfeld theory of conductivity is applied to the calculation of momentum lost by conduction electrons because of collisions with the crystal lattice. The momentum lost by the conduction electrons, suitably averaged, is interpreted as a force per unit volume acting on the crystal lattice. The calculations provide the basis for a microscopic interpretation of the ponderomotive force $\mathbf{f} = (1/c)(\mathbf{j} \times \mathbf{H})$ per unit volume. In the case of metals which conduct in a single band, the ponderomotive force **f** is produced entirely by the action of the Hall electric field on the crystal lattice. When conduction takes place in more than one band **f** is partially caused by the action of the Hall electric field on the crystal lattice and partially caused by collisions of conduction electrons with the lattice. A.

538.633

3752. The Corbino effect and magnetoresistance in bismuth. L. HALPERN AND K. M. KOCH. *Acta Phys. Austriaca*, **5**, 129–33 (*No.* 1, 1951) *In German.*

The Corbino effect (a circumferential current produced in a circular disk by the action of an axial magnetic field on a radial current in the disk) is closely related to the magnetoresistance effect as the resistance of the disk to the circumferential current depends upon the applied field. A simple relation between the effects is derived and compared with experimental results on Bi. A. E. DE BARR

538.652

3753. An apparatus for determining both the dynamic and static magnetostrictive properties of rods of ferromagnetic materials under various polarising fields and at various temperatures. J. C. COOK. *Nuovo Cim.*, **7**, 192–7 (*Suppl. No.* 2, 1950).

An electronic ultramicrometer, employing the frequency change arising from varying a capacity by the strain of the specimen, is used to study the

dynamic and static magnetostrictive properties of rods 18 cm long by 1·25 cm dia. In static tests, positive dilatation occurs with a 36% Ni–Fe alloy, and negative strain with cold-drawn, annealed, quenched, and hot-rolled Ni specimens, the strain at constant polarizing field strength increasing with change of the material in the order quoted. In dynamic tests, the amplitude of the dilatation increases with the applied field for both annealed and hot-rolled Ni and reaches a maximum at about 120 gauss; at higher fields the amplitude decreases again. The apparatus could be used for u.h.f. fatigue testing. A. C. WHIFFIN

538.69 : 535.214

3754. The screw-like motion of metallic particles of size 10^{-3} to 10^{-5} cm in a magnetic field. E. VOTAVA. *Acta Phys. Austriaca*, **5**, 177–84 (*No.* 2, 1951) *In German.*

Further experiments on the so-called Ehrenhaft effect. Investigations were carried out on small iron and steel particles moving under the action of a magnetic field and an intense light beam. The following types of motion were observed visually and microphotographically: (*a*) translation parallel to the lines of force, (*b*) rotation without translation, (*c*) screw-like translation. The last type was found to depend on the field strength and the light intensity.

E. P. WOHLFARTH

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

3755. The band structure of metals. G. V. RAYNOR. *Rep. Phys. Soc. Progr. Phys.*, **15**, 173–248 (1952).

The development of the electron theory of metals is briefly reviewed, and the electronic structures of a selection of monovalent and polyvalent metals are surveyed. Na and Cu are discussed in detail as examples of the alkali metals and the group IB metals respectively. Agreement between experimental and theoretical values of the binding energies, the lattice constants, the compressibilities and the elastic constants is adequate, but difficulties arise in connection with the calculation of the electronic interactions. These difficulties are increased when divalent metals are considered; the divalent metals Ca, Mg and Be are discussed in this connection. The electronic structures of these metals involve overlap of electrons from the first Brillouin zone, and for Mg alloys, lattice spacing relationships may be satisfactorily interpreted on this basis. For trivalent Al, the mathematical difficulties are more serious; it has, however, been possible to explain the elastic anisotropy of this metal, and the calculated variation of elastic constants with electron/atom ratio enables phenomena encountered in Al-rich alloys to be interpreted. The nature of transitional metals is discussed in detail. The possibility of the extension of the theory to alloys is reviewed, with reference to alloys based on Cu and on Ni. Bibl. 99 refs. A.

539.11

3756. Fermi energy of metallic lithium. R. A. SILVERMAN. *Phys. Rev.*, **85**, 227–30 (*Jan.* 15, 1952).

A boundary condition method is developed for deriving the coefficient E_{2n} in the power series expansion of the energy of an electron of wave number k moving in the lattice of an alkali metal. (The entire calculation proceeds within the framework of the Wigner–Seitz atomic sphere approximation.) If the electron wave function is expanded as $\psi_k(\mathbf{r}) = e^{i\mathbf{k}\cdot\mathbf{r}}(u_0 + u_1k + u_2k^2 + \ldots)$ it is shown that the boundary condition $[(\partial/\partial r)(s \text{ part of } u_{2n})]r = r_s = 0$ leads naturally to an evaluation of E_{2n} in terms of values at r_s of homogeneous solutions of the Schrödinger equation and their derivatives with respect to energy and radius. In this way, a simple expression for E_4 is obtained analogous to that derived by Bardeen for E_2. For the case of metallic lithium, this expression leads to the value $E_4 = -0{\cdot}031$, which agrees with that obtained by the more tedious method of evaluating the expectation value of the Hamiltonian using a wave function correct to the second order in k. A.

539.11

3757. Splitting of bands in solids. E. KATZ. Letter in *Phys. Rev.*, **85**, 495–6 (*Feb.* 1, 1952).

Slater [Abstr. 636 (1952)] has shown that gaps may be introduced in such a way that metallic conductors become insulators or semiconductors (NiO or Au at low temp.). It is here pointed out that the development of these gaps is restricted. For a gap to persist, the new zone boundary, introduced by the perturbation potential, must coincide with an equi-energy contour (2-dimensions) or surface (3-dimensions) of the unperturbed lattice in reciprocal space. The low probability of this occurring is exemplified by the case of the 2-dimensional square lattice.

A. J. KENNEDY

539.11

3758. The distribution of electrons round impurities in monovalent metals. J. FRIEDEL. *Phil. Mag.*, **43**, 153–89 (*Feb.*, 1952).

A theoretical investigation is made of the distribution of electrons round a positively charged impurity dissolved in a monovalent metal. Applications are made to dissolved H, where the impurity is a proton, and to atoms such as Zn, Ga, etc., which are usually considered to contribute their electrons to the conduction electrons. In all cases the positive charge must be screened; and in many cases this is shown to occur through the formation of bound states below the level of the Fermi distribution. The relation of these results to the Hume–Rothery rule is discussed. The ideas introduced are used to calculate the heats of solution of H and of polyvalent metals in the noble metals, and to discuss the magnetic properties of these alloys. A detailed discussion is given of X-ray emission and absorption, the vacancy left in the X-ray shell being here treated as the positive impurity. In certain cases quantitative predictions are made about the energies of X-ray absorption

edges. Discussions along the same lines are given of the optical absorption of the noble metals, and of the X-ray emission spectra of certain alloys. A.

539.11

3759. Density of states curve for the 3*d* electrons in nickel. G. C. FLETCHER. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 192–202 (*March*, 1952).

A calculation is made of the energy density of electronic states for the 3*d* electrons in metallic Ni, using the approximation of tight binding. The early stages of the calculations and preliminary results have been previously summarized by Fletcher and Wohlfarth [Abstr. 5555 (1951)]. The theoretical basis of the approximation is outlined and the validity of the underlying assumptions examined. The required overlap integrals are evaluated and the secular equation for the energy as a function of wave vector is solved exactly over the energy range of interest for Ni. The density of states curve is computed graphically. Among results of physical interest obtained are: bandwidth $2{\cdot}7_0$ eV, degeneracy temperature $1{\cdot}4_5\times10^3$ deg K, low temperature electronic heat coefficient $\gamma\ 1{\cdot}6_9\times10^{-3}$ cal. mol^{-1} deg^{-2} (compared with the experimental value of $1{\cdot}74\times10^{-3}$). The results are compared with those obtained by the cellular method of approximation used by Krutter in 1935, and Slater in 1936. A.

539.11

3760. A note on the structure of selenium. E. BILLIG. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 216–21 (*March*, 1952).

The recently established identity of the width of the (optical) energy gap, 2·05 eV, for both amorphous and crystalline Se, suggests that the chain structure of crystalline Se is maintained also in the amorphous phase. The low electrical conductivity of amorphous Se is ascribed to potential barriers existing between individual chains. A.

539.11

3761. Electronic structures and physical properties in the alloy systems nickel-copper and palladium-silver. B. R. COLES. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 221–9 (*March*, 1952).

A comparison is made of the magnetic, electrical and thermo-electric properties of alloys in the two systems, and the lattice spacings, optical properties, electronic specific heat, and X-ray spectroscopy of the Ni–Cu alloys are also considered. Pd–Ag alloys show the behaviour expected of them on the band theory of metals, but Ni–Cu alloys show well-marked and consistent deviations. It is concluded that unoccupied *d*-electron levels exist in the Cu-rich alloys, whereas such levels do not exist in the Ag-rich Pd–Ag alloys. From theoretical considerations it seems unlikely that the unoccupied levels form part of a collective *d*-band, and alternative models are discussed. That the two systems differ so markedly is surprising, but a tentative explanation of the differences is sought in the differing proportions of the atomic volume occupied by the ions in Cu and in Ag. A.

539.11 : 537.211.1

The mean free path of electrons in metals. *See Abstr.* 3578

539.11 : 539.132

3762. A statistical theory of molecular rotation in normal solid hydrocarbons and alcohols. Y. KAKIUCHI. *J. Phys. Soc. Japan*, **6**, 313–20 (*Sept.–Oct.*, 1951).

Molecules in certain normal long chain solid hydrocarbons or alcohols are well known to rotate around their long axis in high temperature phase. A simple statistical theory of rotational transformation similar to Bethe's theory of order-disorder transformation in alloys is attempted, assuming that molecules librate around their equilibrium position and sometimes change their orientation by thermal agitation. A sharp anomaly in observed specific heat is explained as the result of the co-operative transformation from ordered to disordered state in molecular orientation. The large value for the observed heat of transformation is attributed to the internal degrees of freedom of the molecule, perhaps mainly of twisting modes of vibration. The effect of lattice expansion accompanied by the transformation is not taken into account in the present treatment. A.

539.11 : 548.7

3763. The significance of imperfections in crystal structure for the physics of solids. R. W. POHL. *Naturwissenschaften*, **39**, 9–13 (*No.* 1, 1952) *In German.*

The text of a public address read at the annual meeting of the Akademie der Wissenschaften, Göttingen, in June, 1951. Deals with crystal structure imperfections in connection with the following phenomena: hardening, magnetization, and photochemical phenomena in crystals, and the electronic conduction in non-metals. F. LACHMAN

539.11 : 548.7

3764. The stability of hexagonal lattices with a simple law of force. F. R. N. NABARRO AND J. H. O. VARLEY. *Proc. Camb. Phil. Soc.*, **48**, 316–28 (*Pt* 2, 1952).

A hexagonal lattice bound by central forces between nearest neighbours is always close-packed. If there is in addition an energy which, like the Fermi energy of free electrons, depends only on the volume, a close-packed equilibrium structure is still possible, but there may be another hexagonal structure of lower energy. A numerical example is given in which this occurs, the lattice spacing, binding energy and elastic constants being comparable with those of Zn, and the law of force showing no obvious peculiarities. A.

539.11 : 548.7 : 538.222

3765. Matrix elements and operator equivalents connected with the magnetic properties of rare earth ions. K. W. H. STEVENS. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 209–15 (*March*, 1952).

An account is given of the methods used to determine the matrix elements of crystal field potentials with particular reference to rare earth ions. Emphasis is laid on the importance of Wigner coefficients in such problems and the idea of using equivalent angular momentum operators is developed. For convenience in applying the results tables of matrix elements are included. A.

MOLECULAR STRUCTURE 539.13

539.13

3766. Experimental determination of long-range attractive forces. (Provisional communication). J. T. G. Overbeek and M. J. Sparnaay. *Proc. K. Ned. Akad. Wet., B*, **54**, 387–8 (*No.* 4, 1951).

The force F between two highly polished glass plates adjusted to parallelism by Newton's rings at distances varying from 6 000 to 15 000 Å was measured with a spring arrangement. Approximate agreement with the formula $F = A/6\pi d^3$ for London–van der Waals forces [de Boer (1936)] was observed, A being $\sim 2\times10^{-11}$.

539.132 : 535.333

3767. Regularities in the spectroscopic data for the diatomic molecules formed from atoms of groups IV and VI. G. Lovera. *Nuovo Cim.*, **8**, 1014–15 (*Dec.*, 1951) *In Italian.*

The potential function is assumed to be $U = -\alpha/(r+d)^m + \beta/(r+d)^n$, with d, m, n, α, β constant for the members of the group. For the molecules from CO to PbTe, the dissociation energy, D'', is given by $D''_e = 63\cdot53\times10^{-12}/(r''_e + 1)^{1\cdot75}$ ergs, and ω''_e by $\omega''_e = 2\cdot846\times10^4/[\mu(r''_e+1)^{3\cdot75}]^{\frac{1}{2}}$ cm^{-1}.

R. F. BARROW

539.132

3768. Intermolecular forces in CF_4 and SF_7. J. S. Rowlinson. Letter in *J. Chem. Phys.*, **20**, 337 (*Feb.*, 1952).

The Lennard–Jones form for the energy between 2 atoms is used, giving good agreement for r(min) but rather high energies. The intermolecular potentials of CF_4, SF_6 are consistent with known forces between F atoms. J. JACOBS

539.132

3769. The association band of the hydrogen bridge. M. Davies and J. C. Evans. Letter in *J. Chem. Phys.*, **20**, 342 (*Feb.*, 1952).

Wave numbers are given for the N–H stretching vibrations in various amino compounds for monomers and for associated molecules. Conclusions are drawn with respect to the hydrogen bridge frequencies. A correlation between the strength of the bridge and the width of the association band is suggested. The forces contributing to the H-bridge are supposed to be of electrostatic nature. A. J. TAYLOR

539.132

3770. Substituted methanes. VIII. Vibrational spectra, potential constants, and calculated thermodynamic properties for dibromodichloromethane. A. Davis, F. F. Cleveland and A. G. Meister. *J. Chem. Phys.*, **20**, 454–9 (*March*, 1952).

For Pt VII, see Abstr. 2012 (1952). Raman displacements, semiquantitative relative intensities, and quantitative depolarization factors for the liquid, and infrared absorption wave numbers and percent transmission curves for both the liquid and the gas, have been obtained for CBr_2Cl_2. The present and previous data were critically examined and probable values of the wave numbers corresponding to the fundamental vibrational frequencies were determined. Assignments were made for all observed Raman and infrared bands. As a check on the assignments, a normal co-ordinate treatment was undertaken, using a potential function containing all possible quadratic interaction constants. A reasonable set of potential constants was obtained. The observed fundamentals then were used to calculate to a rigid rotator, harmonic oscillator approximation the heat content, free energy, entropy, and heat capacity for 12 temperatures from 100° to 1 000°K, for the ideal gaseous state at 1 atm pressure. A.

539.132 : 535.343.4

3771. The combination band $\nu_1 + \nu_2 + \nu_3$ of heavy water vapor. F. P. Dickey, C. A. Guderjahn and E. D. Palik. *J. Chem. Phys.*, **20**, 375–7 (*March*, 1952).

The vibration-rotation band $\nu_1 + \nu_2 + \nu_3$ in the heavy water vapour (D_2O) spectrum has been remeasured. An analysis of the rotational structure has been carried out. From the interpretation of the data the value of the band centre has been determined as well as the values of the reciprocals of inertia effective in this vibration state. The frequency $\nu_1 + \nu_2 + \nu_3$ is found to be 6 533·4 cm^{-1}. The effective reciprocals of inertia are $A(V) = 15\cdot70$ cm^{-1}, $B(V) = 7\cdot19$ cm^{-1} and $C(V) = 4\cdot69$ cm^{-1}. A.

539.132

3772. Normal vibration frequencies of the trimer of phosphonitrile chloride. J. V. Iribarne and D. G. de Kowalewski. Letter in *J. Chem. Phys.*, **20**, 346–7 (*Feb.*, 1952).

A vibrational analysis is made based on Raman and electron diffraction data, and some force constants are estimated. Two possibilities are suggested for the assignment of the frequencies. A. J. TAYLOR

539.132

3773. The molecular beam electric resonance method study of thallium monochloride. R. O. Carlson, C. A. Lee and B. P. Fabricand. *Phys. Rev.*, **85**, 784–7 (*March* 1, 1952).

The hyperfine structure of the first rotational state of $TlCl^{35}$ and $TlCl^{37}$ was studied by the molecular beam electric resonance method. Two types of molecular transitions were observed: the conventional m_j transition in very weak and in strong Stark fields, the type previously studied in several alkali fluorides; the ΔJ transition ($J = 0 \rightarrow J = 1$), a molecular transition observed for the first time by molecular beam methods in this experiment. Using the m_j type transition, the electric quadrupole interactions involving the chlorine nuclei were determined for the $J = 1$, $v = 0$ state. The values were $eqQ(TlCl^{35}) = -(15\cdot795 \pm 0\cdot004)$ Mc/s, $eqQ(TlCl^{37}) = -(12\cdot446 \pm 0\cdot003)$ Mc/s. The ratio of quadrupole interactions, $1\cdot2691 \pm 0\cdot0004$, is in good agreement with the ratio found for other chlorine molecules and for the chlorine atoms. The quadrupole interaction increased in absolute value by ½% from one vibrational state to the next higher one. The spin-rotation ($\mathbf{I}\cdot\mathbf{J}$) interaction constants in TlCl were $+(73 \pm 2)$ kc/s for Tl, $+(1\cdot2 \pm 0\cdot2)$ kc/s for Cl^{35}, and $+(1\cdot0 \pm 0\cdot2)$ kc/s for Cl^{37}. These quadrupole interaction constants and the spin-rotation interaction constants

or chlorine agree with the values given by the molecular beam magnetic resonance method. From the rotational transition data and the strong Stark field m_J transition data, the following molecular constants were evaluated for $Tl^{205}Cl^{35}$: the rotational constant $B_e = (2\,620{\cdot}1 \pm 2{\cdot}5)$ Mc/s; moment of inertia $A_e = (320{\cdot}2 \pm 0{\cdot}4) \times 10^{-40}$ gm/cm², internuclear distance $r_e = (2{\cdot}541 \pm 0{\cdot}002)$ Å, and dipole moment for the zeroth vibrational state $\mu_0 = (4{\cdot}444 \pm 0{\cdot}014)$ debye. The internuclear distance is in very good agreement with the electron diffraction value, $(2{\cdot}55 \pm 0{\cdot}03)$ Å, in contrast to the case of KCl and CsCl where discrepancies of 3 to 5% exist between electric resonance method values and the electron diffraction experiment values. Within the experimental error, the vibration-rotation interaction constant, (13 ± 1) Mc/s, agrees with the theoretical value predicted assuming a Morse potential for this molecule. A.

539.132

3774. Molecular beam magnetic resonance spectra of $TlCl^{35}$ and $TlCl^{37}$ at zero field. H. J. Zeiger and D. I. Bolef. *Phys. Rev.*, **85**, 788–98 (*March* 1, 1952).

The molecular beam magnetic resonance method has been used to investigate the spectra of $TlCl^{35}$ and $TlCl^{37}$ at zero field. A splitting of the quadrupole line for both isotopes is observed and is attributed to a cosine coupling of the form $c_a\mathbf{I}\cdot\mathbf{J}$, between the chlorine spin $\mathbf{I}_a$ and the rotational angular momentum of the molecule $\mathbf{J}$. It is assumed that the gradient of the electric field at the position of the chlorine nucleus q is a function of the internuclear distance R of the form $q(R) = q^{(0)} + q^{(1)}[(R - R_e)/R_e] + q^{(2)}[(R - R_e)/R_e]^2 + \ldots$ where R_e is the equilibrium value of R in the zeroth vibrational and rotational state ($v = 0$, $J = 0$). The average of $q(R)$ over the vibration and rotation of the molecule is shown to lead to a v and J dependence of the quadrupole coupling eqQ of the form $eqQ = e\bar{q}Q + eq^{(J)}QJ(J+1) + eq^{(v)}Qv$. The variation of eqQ with v and J explains the asymmetry observed in the TlCl line shapes. The energy levels and transition frequencies are calculated for TlCl, a heteronuclear diatomic molecule with one nucleus having a quadrupole coupling with v and J dependence, and a cosine coupling with $\mathbf{J}$; and the second nucleus having a cosine coupling with $\mathbf{J}$. A detailed analysis of the line shape is presented. The results for Cl^{35} in $TlCl^{35}$ are: $|e\bar{q}Q|/h = 15{\cdot}788 \pm 0{\cdot}02$ Mc/s, $|eq^{(v)}Q|/h = 96$ kc/s, $|eq^{(J)}Q|/h = 18{\cdot}4$ c/s, $|c_a|/h = 1{\cdot}4 \pm 0{\cdot}1$ kc/s. The results for Cl^{37} in $TlCl^{37}$ are: $|e\bar{q}Q|/h = 12{\cdot}425 \pm 0{\cdot}02$ Mc/s, $|eq^{(v)}Q|/h = 76$ kc/s, $|eq^{(J)}Q|/h = 16{\cdot}4$ c/s, $|c_a|/h = 1{\cdot}1 \pm 0{\cdot}1$ kc/s. $eq^{(v)}Q$ and $eq^{(J)}Q$ are shown to have the same sign as $e\bar{q}Q$ for both $TlCl^{35}$ and $TlCl^{37}$. The zero field lines for Na^{23} in $Na^{23}F$ and $Na^{23}Cl$ are also discussed and are analysed using the same theory. The results for Na^{23} in $Na^{23}Cl$ are: $|e\bar{q}Q|/h = 5{\cdot}608 \pm 0{\cdot}02$ Mc/s, $|eq^{(v)}Q|/h \sim 88$ kc/s, $|eq^{(J)}Q|/h \sim 24$ c/s, $|c_a|/h \sim 1$ kc/s. The results for Na^{23} in $Na^{23}F$ are: $|e\bar{q}Q|/h = 8{\cdot}40 \pm 0{\cdot}02$ Mc/s, $|eq^{(v)}Q|/h \sim 80$ kc/s, $|eq^{(J)}Q|/h \sim 32$ c/s, $|c_a|/h \sim 1$ kc/s. The signs of $eq^{(v)}Q$ and $eq^{(J)}Q$ are shown to be opposite to the sign of $e\bar{q}Q$ for both $Na^{23}Cl$ and $Na^{23}F$. A.

539.132

3775. Molecular beam magnetic resonance spectra of $Rb^{87}F$ and $Rb^{87}Cl$ at zero field. D. I. Bolef and H. J. Zeiger. *Phys. Rev.*, **85**, 799–802 (*March* 1, 1952).

The radiofrequency spectra of $Rb^{87}F$ and $Rb^{87}Cl$ were investigated by the zero field molecular beam magnetic resonance method. The quadrupole line was found to be split into a series of component lines. The separations between the lines, as well as the shapes of the lines, are explained by taking into account the effects of (1) a cosine coupling of the form $c_a\mathbf{I}\cdot\mathbf{J}$ between the spin of Rb^{87}, $\mathbf{I}_a$, and the rotational angular momentum of the molecule $\mathbf{J}$; and (2) the dependence of the quadrupole interaction constant eqQ on vibrational quantum number v and rotational quantum number J of the form: $eqQ = e\bar{q}Q + eq^{(J)}QJ(J+1) + eq^{(v)}Qv$. The results for Rb^{87} in $Rb^{87}F$ are: $|e\bar{q}Q|/h = 33{\cdot}96 \pm 0{\cdot}02$ Mc/s, $|eq^{(v)}Q|/h = 410 \pm 40$ kc/s, $|eq^{(J)}Q|/h = 26 \pm 4$ c/s, $|c_a|/h = 1{\cdot}1 \pm 0{\cdot}1$ kc/s. $eq^{(v)}Q$ and $eq^{(J)}Q$ are shown to have signs opposite to that of $e\bar{q}Q$. The results for Rb^{87} in $Rb^{87}Cl$ are: $|e\bar{q}Q|/h = 25{\cdot}37 \pm 0{\cdot}04$ Mc/s, $|eq^{(v)}Q|/h = 230 \pm 50$ kc/s, $|eq^{(J)}Q|/h = 12 \pm 2$ c/s, $|c_a|/h = 1{\cdot}0 \pm 0{\cdot}1$ kc/s. $eq^{(v)}Q$ and $eq^{(J)}Q$ are shown to have signs opposite to that of $e\bar{q}Q$. A.

539.132

3776. On the evaluation of certain integrals occurring in the method of antisymmetrized molecular orbitals. E. Scrocco and O. Salvetti. *Ric. Sci.*, **21**, 1629–39 (*Sept.*, 1951) *In Italian.*

The integral $\int \phi_1(1)\phi_2(1)\frac{2}{r_{12}}\phi_2^2(2)d\tau$ was calculated for the case when ϕ_1 and ϕ_2 are Slater p_z functions around different atoms and with different values of the nuclear charge. A table of numerical values is appended. L. Pincherle

539.132 : 535.343.4–15

Rotational analysis of nitrosyl fluoride. *See Abstr.* 3471

539.132 : 538.224

3777. Quantum calculation of the diamagnetic anisotropy of organic molecules. III. Complex aromatic hydrocarbons. G. Berthier, M. Mayot, A. Pullman and B. Pullman. *J. Phys. Radium*, **13**, 15–20 (*Jan.*, 1952) *In French.*

For Pt II, see Abstr. 441 (1952). The molecular orbital method was applied to conjugated hydrocarbons with at least 4 aromatic nuclei. No simple relation with resonance energy emerged; the delocalization of mobile electrons may even reduce the diamagnetic susceptibility $\perp$ to the molecular plane. J. Jacobs

539.132 : 539.152.2

3778. Use of HD for experiments on the proton-deuteron magnetic moment ratio. N. F. Ramsey. Letter in *Phys. Rev.*, **85**, 688 (*Feb.* 15, 1952).

High precision measurements of this ratio are limited by the uncertainty in the difference of the magnetic shielding corrections for molecules identical except for the interchange of D and H. It is pointed out that this uncertainty can be overcome by observing both the proton and the deuteron resonance in the molecule HD. L. Pincherle

539.133

3779. Prediction of internuclear distances of diatoms. C. H. D. CLARK. Letter in *Nature* [*Lond.*] **168,** 911–12 (*Nov.* 24, 1951).

Satisfactory agreement—exemplified by figures for CO, N_2, NO and O_2—between predicted and subsequent experimental values is obtained. R. F. BARROW

539.133

3780. An interpretation of bond lengths in alkali halide gas molecules. R. T. SANDERSON. Note in *J. Amer. Chem. Soc.*, **74,** 272–4 (*Jan.* 5, 1952).

Contraction or expansion of the electronic sphere of atoms or ions on losing or gaining electrons is used to determine bond lengths as sums of "adjusted radii." A relation between radii and electronegativity lies in the difference of average electronic density of inert element atoms and isoelectronic ions. J. JACOBS

539.133

3781. General equations for the calculation of molecular polarizabilities. J. GUY AND M. HARRAND. *C.R. Acad. Sci.* [*Paris*] **234,** 616–18 (*Feb.* 4, 1952) *In French.*

A generalization of Slater and Kirkwood's method for spherically symmetric atoms. Expressions are found for the components of the polarizability tensor. These should prove useful when the principal polarizability axes are not obvious. J. JACOBS

539.133

3782. On the polarizability of the hydrogen molecule. E. ISHIGURO, T. ARAI, M. MIZUSHIMA AND M. KOTANI. *Proc. Phys. Soc.* [*Lond.*] *A,* **65,** 178–87 (*March,* 1952).

The polarizability of the hydrogen molecule is calculated theoretically. The energy of the molecule, under an external electrostatic field, is calculated by the variation method, using 11 + 10 terms and 11 + 9 terms James–Coolidge type wave functions, for the polarizability parallel to and perpendicular to the molecular axis respectively. By expanding the energy in powers of the field strength, the polarizability is determined. By using a Morse function for the adiabatic potential of the molecule, the 0–0 and 0–1 matrix elements of the polarizability between vibrational states are calculated, with the result: $\alpha_{00} = 7{\cdot}89$, $\gamma_{00} = 2{\cdot}78$, $\alpha_{01} = 1{\cdot}39$, $\gamma_{01} = 0{\cdot}90$ for ordinary hydrogen H_2, and $\alpha_{00} = 7{\cdot}75, \gamma_{00} = 2{\cdot}68, \alpha_{01} = 1{\cdot}13$, $\gamma_{01} = 0{\cdot}71$ for heavy hydrogen D_2 (in units of 10^{-25} cm^3), where α is the mean polarizability and γ the anisotropy. A.

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

3783. The shell structure of atomic nuclei. II. E. BAGGE. Note in *Naturwissenschaften,* **38,** 473–5 (*No.* 20, 1951) *In German.*

For Pt I, see Abstr. 7189 (1949). As an alternative to the strong spin-orbit coupling hypothesis of the shell model it is suggested that the correct magic numbers can be obtained if, in addition to the regular solutions of the wave equation in an oscillator potential, one also includes those (integrably) diverging like $1/r$ at the origin. W. J. SWIATECKI

539.152.1

3784. The suggestion of a structure number 6 in atomic nuclei. H. E. BINKELE. *Naturwissenschaften,* **38,** 546 (*No.* 23, 1951) *In German.*

539.152.1

3785. A study of the 8·20-MeV level of C^{13}. R. RICAMO. Letter in *Nuovo Cim.*, **8,** 893–5 (*Nov.*, 1951) *In Italian.*

The variation, with energy of bombarding neutrons, of the total scattering cross-section of C^{12} shows that the 8·20 MeV level of C^{13} has spin 3/2; a study of the angular distribution of the neutrons scattered at angles near $\pi/2$ shows that, almost certainly, $l = 2$. L. PINCHERLE

539.152.1

3786. Nuclear radii. D. CURIE. *J. Phys. Radium,* **12,** 941–9 (*Dec.*, 1951) *In French.*

A survey is given of the methods available for determining nuclear radii, and the results obtained. The variation of the nuclear radius with mass number is discussed with particular reference to nuclear shell structure. J. HUGHES

539.152.1

3787. On the nuclear scheme of thorium C′. S. ROSENBLUM. *C.R. Acad. Sci.* [*Paris*] **234,** 202–4 (*Jan.* 7, 1952) *In French.*

It is suggested that the excited levels of ThC′ can be described by $E_n = k[2 + (n-2)^{-1}] + e$ where n is an integer. W. J. SWIATECKI

539.152.1

3788. A two model interpretation of a nuclear spectrum. D. R. INGLIS. Letter in *Phys. Rev.*, **85,** 492–3 (*Feb.* 1, 1952).

Reasons are given for assuming the ground, 0·48 and 4·8 MeV levels of Li^7 to be states of the α-particle model and the 7·4 MeV level to be a central model state. W. J. SWIATECKI

539.152.1

3789. The pairing effect in nuclei and the beta-labile elements. T. P. KOHMAN. *Phys. Rev.*, **85,** 530–1 (*Feb.* 15, 1952).

It has been shown previously that in certain regions of nuclides the pairing energy of protons exceeds that of neutrons. Statistical examination of the β-stable odd-mass nuclides shows that this situation is probably fairly general except for light elements. Theoretical explanations of the effect are suggested. Its bearing on the β-lability of technetium and promethium and the possible β-lability of astatine and indium is discussed. A.

539.152.1

3790. Classification of energy levels in Al^{25}. L. J. KOESTER, JR. *Phys. Rev.*, **85,** 643–52 (*Feb.* 15, 1952).

The differential cross-section for the elastic scattering of protons by Mg^{24} has been measured by Mooring, Koester, Goldberg, Saxon and Kaufmann in the range of bombarding energies between 0·4 MeV and 3·95 MeV. In the present work, the energy dependence of this cross-section is interpreted in terms of the combination of Coulomb and nuclear

otential scattering with resonant scattering. This esonant scattering arises from the excitation of nergy levels of the compound nucleus, Al^{25}. The eneral trend of the observed cross-section between ·4 MeV and 3·4 MeV, including the three broadest esonances, is well fitted theoretically. A method is eveloped to calculate the effects of imperfect energy esolution on the shapes of resonances, and the results re used to rule out certain assignments. The excited tates corresponding to the three broadest resonances ave been classified as follows: 3·11 MeV, $P_{3/2}$; ·88 MeV, $P_{1/2}$; 5·34 MeV, $P_{3/2}$. These energies are he dissociation energy, which is 2·32 MeV, plus the esonant energy in the centre-of-mass system. A wofold ambiguity remains in the angular momentum alues assigned to the narrow resonances because the experimental resolution was not sufficient to determine heir true maximum cross-sections. The assignments are as follows: 3·75 MeV, *F*; 3·91 MeV, *D*; 4·25 MeV, *D*; 4·63 MeV, *D*; 5·83 MeV, *D*. The last assignment is somewhat doubtful because the phase shifts due to higher, unobserved resonances are not known. The odd parity levels have reduced widths between 10% and 30% of the value corresponding to single-particle excitation, while the even parity levels have reduced widths only a few tenths of one per cent of this value. An explanation of the level structure is offered in terms of a nuclear shell model. The spin-orbit splitting of the 3·11 MeV and 3·88 MeV *P* states is small compared with doublet splitting observed in closed-shell plus-one nuclei. A.

539.152.1

3791. A steady state transient technique in nuclear resonance. R. Gabillard. Letter in *Phys. Rev.*, **85**, 694 (*Feb.* 15, 1952).

New techniques are suggested for the measurement of T_2 in liquids in the presence of field inhomogeneities larger than the mean value of the intramolecular field. L. PINCHERLE

539.152.2

3792. On the quadrupole moment of the gold nucleus. W. v. Siemens. Note in *Naturwissenschaften*, **38**, 455 (*No.* 19, 1951) *In German.*

Spectroscopic analysis of the Au I lines at 5 065, 5 837, 6 287 Å leads to a value $Q \simeq +0{\cdot}5\times10^{-24}$ cm². The assumed magnetic moment was 0·76 n. magneton. W. J. SWIATECKI

539.152.2

3793. Nuclear magnetic moment of scandium of mass 45. D. M. Hunten. *Canad. J. Phys.*, **29**, 463–9 (*Nov.*, 1951).

By the method of nuclear magnetic resonance, the magnetic moment of Sc^{45} (without diamagnetic correction) is found to be $4{\cdot}74916 \pm 0{\cdot}00012$. The correction is $+0{\cdot}00717$ with unknown and possibly large error. The equipment designed to search for magnetic resonance by varying the field of the magnet is described, with special emphasis on the magnet current regulator. A.

539.152.2

3794. The spin and quadrupole moment of Se^{79}. W. A. Hardy, G. Silvey and C. H. Townes. Letter in *Phys. Rev.*, **85**, 494–5 (*Feb.* 1, 1952).

The spin was uniquely determined as 7/2 from the hyperfine structure pattern of the $J = 2 \rightarrow 3$ transition of $OCSe^{79}$. This disagrees with the shell model. The value $Q = 1{\cdot}2\times10^{-24}$ cm² ± 50% was found. W. J. SWIATECKI

539.152.2

3795. The nuclear magnetic moment of S^{33} from microwave spectroscopy. J. R. Eshbach, R. E. Hillger and M. W. P. Strandberg. *Phys. Rev.*, **85**, 532–9 (*Feb.* 15, 1952).

The magnetic dipole moment of the S^{33} nucleus was determined by means of the Zeeman effect on the hyperfine pattern of the $J = 1 \rightarrow 2$ rotational absorption of the molecule $O^{16}C^{12}S^{33}$ at about 24 020 Mc/s. The result is $\mu(S^{33}) = +0{\cdot}633 \pm 0{\cdot}010$ nuclear magneton. The sign of this moment was determined by using circularly polarized microwave radiation with σ-type Zeeman observations. The frequencies of all of the components of the hyperfine pattern were measured. They all fit the nuclear electric quadrupole coupling theory to within ± 0·01 Mc/s. The measured value for eqQ of the S^{33} nucleus in $O^{16}C^{12}S^{33}$ is $eqQ(O^{16}C^{12}S^{33}) = -29{\cdot}07 \pm 0{\cdot}01$ Mc/s. A.

539.152.2

3796. A determination of the nuclear magnetic moment of Co^{60}, using the method of nuclear alignment. B. Bleaney, J. M. Daniels, M. A. Grace, H. Halban, N. Kurti and F. N. H. Robinson. Letter in *Phys. Rev.*, **85**, 688 (*Feb.* 15, 1952).

See Abstr. 5572 (1951), 644 (1952). The anisotropy of the γ-radiation depends on temperature through the Boltzmann factor $\exp(\mu H/kTI)$, where μ and I are the magnetic moment and the spin of Co^{60}. The effective magnetic field H can be deduced from measurements of the h.f. splitting of the paramagnetic resonance spectrum of Co^{59} in the same salt and from the known magnetic moment of Co^{59}. Assuming $I = 5$, the alignment effect then gives $\mu(Co^{60}) = 3{\cdot}0 \pm 0{\cdot}5$ n.m. (the sign cannot be deduced from this experiment). L. PINCHERLE

539.152.2 : 538.222

3797. A physical model to demonstrate nuclear and paramagnetic resonance. E. F. Carr and C. Kikuchi. Note in *Amer. J. Phys.*, **20**, 110–11 (*Feb.*, 1952).

539.153

3798. Wave functions for the neutral calcium atom. E. Trefftz. *Z. Astrophys.*, **29**, 287–303 (*No.* 3, 1951) *In German.*

Methods used for calculation of the states of Mg I [Abstr. 5203–4 (1950), 2928 (1951)] are applied in a calculation of the wave functions for the states $4\,^1S$, $4\,^1P$, $4\,^3P$ and $3\,^3D$ of Ca. R. A. NEWING

539.153 : 535.343

3799. The energy level system of an ion having 2 outer *d*-electrons in a field of octahedral symmetry. F. E. Ilse and H. Hartmann. *Z. Naturforsch.*, **6a**, 751–4 (*Dec.*, 1951). **On the light absorption of complex ions of the trivalent vanadium having octahedral symmetry.** H. Hartmann and H. L. Schläfer. *Ibid.* (754–9). **On the absorption spectra of complex ions of trivalent transition elements having octahedral symmetry.** H. Hartmann and H. L. Schläfer. *Ibid.* (760–3) *In German.*

The splitting of the energy levels is discussed in the

first paper using group theory and perturbation theory. The long-wave absorption bands of ions of the trivalent vanadium of the form VA_3^{+++} (where A stands for H_2O, CH_3OH, etc.) and of the ions Ti^{+++}, V^{+++}, Cr^{+++}, Mn^{+++}, Fe^{+++} are then shown, in the last two papers, to be in agreement with the calculations. See also Abstr. 465 (1952).

P. T. LANDSBERG

539.153 : 539.166.835

Positron annihilation and positronium formation. *See Abstr.* 3843–6

539.153.1 : 548.7

3800. Some remarks on the ionic radii of iron-group elements. The influence of crystalline field. J. H. VAN SANTEN AND J. S. VAN WIERINGEN. *Rec. Trav. Chim. Pays-Bas*, **71**, 420–30 (*March*, 1952).

The ionic radii of iron group elements do not decrease monotonically from Ca towards Zn but show maxima at configurations d^4, d^5 and, possibly, d^9, d^{10}. An explanation is offered, based upon a heteropolar model where the influence of the other ions on the electronic distribution of 3*d* electrons is considered as a purely electrostatic influence of their net charges. The maxima are explained by the influence of a preponderantly cubic crystalline field, both for negligible and strong inter-electronic interaction. A.

539.153.4

3801. Note on the mass-defect of hydrogen atoms. M. BUNGE. *Acta Phys. Austriaca*, **5**, 77–9 (*No.* 1, 1951) *In German.*

It is argued that the energy of a hydrogen atom in an arbitrary Lorentz system cannot be calculated directly from the relativistic wave-equation.

J. R. MADDOX

539.155

3802. The masses of Na^{23}, K^{39} and K^{41}. A. HENGLEIN. *Z. Naturforsch.*, **6a**, 745–50 (*Dec.*, 1951) *In German.*

An ion-source of the Shaw type [Abstr. 3386 (1949)] was investigated using a parabola (crossed fields) spectrograph, and then applied to a double-focusing mass-spectrograph. Masses were determined of Na^{23} ($22{\cdot}99665 \pm 0{\cdot}00008$ mass units), K^{41} ($CH_3CN^+ - K^{41+} = 65{\cdot}13 \pm 0{\cdot}05 \times 10^{-3}$ m.u.) and K^{39} ($CHCN^+ - K^{39+} = 47{\cdot}58 \pm 0{\cdot}08 \times 10^{-3}$ m.u.).

A. O. STANESBY

539.155

3803. Masses of lead and bismuth. P. I. RICHARDS, E. E. HAYS AND S. A. GOUDSMIT. *Phys. Rev.*, **85**, 630–1 (*Feb.* 15, 1952).

The masses of Pb^{208} and Bi^{209} have been determined by measuring the time of flight of their ions in a magnetic field. The mass values are: $Pb^{208} = 208{\cdot}0416 \pm 0{\cdot}0015$, $Bi^{209} = 209{\cdot}0466 \pm 0{\cdot}0015$, $Bi^{209} - Pb^{208} = 1{\cdot}0050 \pm 0{\cdot}0015$. A.

539.155 : 539.172.13

3804. Determination of the atomic mass of phosphorus by a nuclear reaction method. F. A. EL-BEDEWI, R. MIDDLETON AND C. T. TAI. Letter in *Nature* [*Lond.*] **169**, 235 (*Feb.* 9, 1952).

The mass of P^{31} is deduced to be $30{\cdot}98375 \pm 0{\cdot}00009$ m.u. from the *Q*-value of the reaction $P^{31}(d, n)S^{32}$ as calculated from the range and orientation of recoil protons observed in photographic emulsions exposed to the *n*'s produced by 8·13 MeV *d*'s on a thin P^{31} target. The masses of P^{30} and P^{32} are then deduced from the known reactions $P^{31}(\gamma, n)P^{30}$ and $P^{31}(d, p)P^{32}$. W. J. SWIATECKI

539.155.2

3805. The isotopic abundance of K^{40}. C. REUTERSWÄRD. *Ark. Fys.*, **4**, 203–5 (*Paper* 7, 1951).

A mass spectrometer with a thermionic emission ion source was used with voltage scanning, and the mass discrimination was evaluated by comparison with Nier's value of $K^{39} : K^{41}$ [Abstr. 6025 (1950)]. The mean of 60 determinations gave $7\,900 \pm 40$ for $K^{39} : K^{40}$, or, including Nier's errors, $1{\cdot}18 \times 10^{-4}$ for the isotopic abundance of K^{40}. T. G. PICKAVANCE

539.155.2 : 533.15

3806. A new method for the enrichment of gaseous isotopes in the transition range between Knudsen- and Poiseuille-flow. H. D. BECKEY AND W. E. GROTH. Note in *Naturwissenschaften*, **38**, 558 (*No.* 24, 1951) *In German.*

There is no separation in the stationary state in a tube of radius $r \ll$ the mean free path λ, along which a temperature gradient is maintained. If a return flow of Poiseuille type is provided for relieving the Knudsen pressure, the lighter component is enriched at the hotter end. If, however, $r/\lambda \simeq 0{\cdot}1$, the lighter component is enriched at the cooler end in the absence of return flow. The two effects which cancel separation in the first case diminish for $r \to \lambda$ in such a manner that the one driving the light component to the cold end predominates. H. LONDON

539.155.2 : 533.15

3807. Distribution of components of ternary isotopic mixture along Clusius–Dickel column. F. K. ELDER, JR AND R. E. MCDONALD. Letter in *Phys. Rev.*, **85**, 500–1 (*Feb.* 1, 1952).

A hot-wire glass column 3 metres long, filled with Ne, and fitted with 6 sampling ports along its length is described. Plots are given showing concentrations of the 3 Ne isotopes at various times as equilibrium is approached. R. H. DAVIES

539.155.2 : 539.163.2

3808. The tritium isotope of hydrogen of mass 3. Bibliography and review. P. VERZAUX. *J. Phys. Radium*, **13**, 94–106 (*Feb.*, 1952) *In French.*

539.155.2 : 542.48

3809. The separation of isotopes by fractional distillation. I. DOSTROVSKY, J. GILLIS AND D. R. LLEWELLYN. Letter in *Bull. Res. Coun. Israel*, **1**, 120–1 (*March*, 1951).

Mathematical solutions are given for the approach to equilibrium of the isotope concentration in the boiler of a packed distillation column, in terms of the unit process separation factor and the equivalent stage length of the column. The cases with and without continuous withdrawal of liquid product are dealt with, taking into account liquid and vapour holdups. W. H. DENTON

ADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16 : 539.234

3810. On the evaporation of radium E. T. MIKUMO. *.R. Acad. Sci.* [*Paris*] **234**, 89–91 (*Jan.* 2, 1952) *In rench.*

A method involving evaporation in a stream of ydrogen is described for the deposition of an intense aE source on to a metallic support. J. J. WILKINS

539.162 : 539.154.2

3811. The transuranium elements. W. Q. HULL. *hem. Engng News*, **30**, 232–7 (*Jan.* 21, 1952).

A non-specialist account of the history of the iscovery of the transuranium elements, their elec-onic configuration and place in the periodic table, otopes and radioactive properties.

539.163

3812. The angular correlation of two successive uclear radiations. S. P. LLOYD. *Phys. Rev.*, **85**, 04–11 (*March* 1, 1952).

A general formula is derived, using group-theoretic nethods, which gives the correlation as series in acobi polynomials whose argument depends on the ngle between the radiations. The coefficients factor nto quantites depending on the separate nuclear ransitions, and the factors are worked out explicitly or the directional correlation cases where one of the nterfering radiation angular momenta is the lowest or next-lowest allowed by conservation of angular momentum. Correction factors are given for con-verting lowest multipole γ–γ correlations into an extensive class of directional correlations. A.

539.163

3813. The theory of the use of alpha ray ranges in nuclear emulsions for the determination of the radio-active contents of materials. J. H. J. POOLE AND C. M. E. MATTHEWS. *Sci. Proc. Roy. Dublin Soc.*, **25**, 305–16 (*Dec.* 19, 1951).

Two methods are developed for determining the Th/U ratio in a radioactive source from the distribu-tion of the horizontal α ranges in a photographic emulsion. Both methods are calculated for thin and thick sources. In the first method, the ratio of (*a*) the number of tracks per cm² whose horizontal range exceeds the maximum range of RaC′, to (*b*) the total number of tracks per cm², is found. In the second, the ratio (*a*) to (*c*), the number of tracks with horizontal range between the maxima of RaC′ and ThA, is found. Experimental results confirmed the theory, but results with natural materials were confusing.

F. R. HOLT

539.163

3814. On the non-existence of a long-lived isomer of Ti^{51}. W. FORSLING AND A. GHOSH. *Ark. Fys.*, **4**, 331–6 (*Paper* 15, 1952).

See Abstr. 9006 (1950). Titanium from a pile-irradiated sample was separated in the isotope separator. No activity from Ti^{51} was detected. Radiochemical separation also proved that the activity of the sample did not belong to Ti but to Ta occurring as impurity. β-spectra of the original sample and that of the chemically separated Ta showed close similarity to each other and to the spectrum of Ta^{182} reported by others. A.

539.163.1

3815. The half-life of iridium 192. J. KASTNER. *Canad. J. Phys.*, **29**, 480–1 (*Nov.*, 1951).

A Lauritsen electroscope was used to compare the intensity of an Ir^{192} source with a Ra standard. The result of a least-squares fitting of the decay curve was a half-life of Ir^{192} of $74{\cdot}37 \pm 0{\cdot}07$ days. A.

539.163.1

3816. The α-half-life of Am 241. B. G. HARVEY. Letter in *Phys. Rev.*, **85**, 482 (*Feb.* 1, 1952).

The α-activity of microgram samples of AmO_2 was counted in a low solid-angle ppl. α-counter (methane-filled). The specific activity of AmO_2 was $6{\cdot}18_4 \times 10^6$ α-disintegrations/min μg AmO_2, and the α-half-life of Am^{241} was $470 + 5 - 10$ years. A. O. STANESBY

539.163.2

3817. Term schemes of some niobium isotopes. P. PREISWERK AND P. STÄHELIN. *Helv. Phys. Acta*, **24**, 300–1 (*No.* 4, 1951) *In German.*

The β-disintegration of Nb^{96} into Mo^{96} was investi-gated. Nine γ-components were found; a decay scheme which accounts for eight of them is given. 10-day Nb^{92} was found to decay principally by electron capture followed by 930 keV γ-emission. 62-day Nb^{91*} and 80-hour Nb^{95*} have transition energies of 105 and 232 keV respectively. F. R. HOLT

539.163.2

3818. The decay of Pt^{195}, Au^{195}, Pt^{197}, Au^{199}. O. HUBER, F. HUMBEL, H. SCHNEIDER AND A. DE SHALIT. *Helv. Phys. Acta*, **24**, 629–31 (*No.* 6, 1951).

The previously accepted values have been rechecked and improved, and new decay schemes are proposed for Pt^{195}, Hg^{197} and Hg^{199} which are strikingly similar to one another.

539.163.2

3819. *L*-electron capture and alpha-decay in Np^{235}. R. A. JAMES, A. GHIORSO AND D. ORTH. Letter in *Phys. Rev.*, **85**, 369–70 (*Jan.* 15, 1952).

The radiations from a strong source of Np^{235} showed a small α-particle group (5×10^{-5} of total disintegra-tions; $E_\alpha = 5{\cdot}06 \pm 0{\cdot}02$ MeV, disintegration energy $5{\cdot}15$ MeV; partial ½-life 2×10^4 yr) and $K(< 0{\cdot}10)$ and $L(> 0{\cdot}90)$ X-rays from orbital-electron capture (mainly from vacancies in the L_{II} and L_{III} levels). The ½-life was 410 ± 10 days. A. O. STANESBY

539.163.2

3820. The application of proportional γ-ray counters to the determination of the decay scheme of I^{131}. P. E. CAVANAGH. *Phil. Mag.*, **43**, 221–30 (*Feb.*, 1952).

A naphthalene-anthracene crystal has been used to separate the high-energy γ-rays in I^{131} from the main low-energy component. Coincidence absorption measurements with β-rays and the high-energy γ-rays show that the latter are in cascade with β-rays of maximum energy 315 keV. Consideration of the bias curve of these coincidences, however, shows that the coincidence β-spectrum is complex and may be analysed into components of maximum energy 328 and 246 keV in the ratio (2 : 1) expected if they are in cascade with the 638 and 720 keV γ-rays respec-tively, which are known to be emitted. This suggests

that the latter are emitted in transitions to the ground state of Xe^{131}. A.

539.163.2

3821. Genetic relationships and fission yields of members of the mass-115 decay chain. A. C. WAHL AND N. A. BONNER. *Phys. Rev.*, **85**, 570–7 (*Feb.* 15, 1952).

The 21 minute Ag^{115} has been found to decay to both Cd^{115} isomers, 9% going to the 43-day state and 91% to the 53-hour state. No evidence was found for the decay of either Cd isomer to the other. The 53-hour Cd isomer decays to the 4·5-hour In^{115m}, but $< 0{\cdot}02\%$ of the 43-day Cd decays to In^{115m}. The U^{235} thermal neutron fission yields of the 21-minute Ag, 53-hour Cd, and 43-day Cd were determined to be $0{\cdot}0078\%$, $0{\cdot}0098\%$, and $0{\cdot}00071\%$, respectively. All of the 43-day Cd isomer formed in fission grows from the 21-minute Ag, but 28% of the 53-hour isomer is formed by some other path. The fission yield of each of the Cd isomers increases one hundredfold when the energy of the neutrons is increased to 14 MeV. Evidence is presented for the formation of 3·5-year Cd^{113m} in approximately $5\times10^{-5}\%$ yield from the thermal-neutron fission of U^{236}. A.

539.163.2

3822. Decay of Te^{125m}. J. C. BOWE AND P. AXEL. *Phys. Rev.*, **85**, 858–62 (*March* 1, 1952).

The two-step isomeric transition in Te^{125m} was studied with proportional counters in coincidence, a NaI crystal scintillation spectrometer and a thin lens β-ray spectrometer. The following branching fractions were determined: 110 keV transition: K conversion $= 0{\cdot}54 \pm 0{\cdot}01$, other conversion $= 0{\cdot}46$, unconverted γ-ray $= 0{\cdot}0034 \pm 0{\cdot}0005$; 35·5 keV transition: K conversion $= 0{\cdot}80 \pm 0{\cdot}05$, L conversion $= 0{\cdot}11 \pm 0{\cdot}02$, M conversion $= 0{\cdot}02 \pm 0{\cdot}004$, unconverted γ-ray $= 0{\cdot}07 \pm 0{\cdot}02$. These data are shown to completely confirm the level assignments in Te^{125} as $s_{1/2}$, $d_{3/2}$ and $h_{11/2}$. In addition, comparison with theoretical conversion coefficients show an agreement between experiment and extrapolated theoretical values. The second transition (35·5 keV) is almost entirely magnetic dipole; an upper limit of about 1% can be placed on the electric quadrupole admixture. A.

539.163.2

3823. On the decay of $Kr^{88} \rightarrow Rb^{88} \rightarrow Sr^{88}$. S. THULIN. *Ark. Fys.*, **4**, 363–81 (*Paper* 19, 1952).

Methods of extracting fission gases from *n*-irradiated U samples are described, as well as the technique of preparing weightless β-samples of Rb^{88} on thin backing foils. The electromagnetic separation of genetic activities is discussed in connection with the pair $Kr^{88} + Rb^{88}$. A Fermi analysis of the β-spectrum of Rb^{88} gives three components of energies 5·30, 3·6 and 2·5 MeV. The later value removes an earlier uncertainty in the decay scheme of Rb^{88} [Abstr. 2974 (1951)]. An analysis of the Kr^{88} difference spectrum gives β-components of energies 2·7, 0·9 and 0·52 MeV. Conversion lines of a 28·0 keV γ-ray were found. $e^-\beta$-coincidence measurements in the β-spectrometer show that this γ-ray is in coincidence with a β-component of energy $\sim 0{\cdot}5$ MeV. The possibility that the 2·8 MeV β-component of Kr^{88} may be of first forbidden shape is pointed out. The question of the existence of a 0·9 MeV β-component in Kr^{88} is discussed, as well as the low experimental internal conversion coefficient of the 28 keV γ-ray. A.

539.163.2, 539.155.1

3824. Beta-activity of Si^{31} and the masses of the Al and Si isotopes. H. T. MOTZ. Letter in *Phys. Rev.*, **85**, 501–2 (*Feb.* 1, 1952).

Si^{31} obtained by the $P^{31}(n, p)Si^{31}$ reaction was examined in a thin lens β-spectrometer with a momentum resolution of 1·5%; $E_{max} = 1\,471 \pm 8$ keV, and $\frac{1}{2}$-life $= 159 \pm 1$ min. Consistent values for the mass defects of related nuclides are given: Al^{27}: $-9{\cdot}860 \pm 0{\cdot}035$; Al^{28}: $-9{\cdot}170 \pm 0{\cdot}035$; Si^{28}: $-14{\cdot}163 \pm 0{\cdot}030$; Si^{29}: $-14{\cdot}281 \pm 0{\cdot}030$; Si^{30}: $-16{\cdot}687 \pm 0{\cdot}035$; Si^{31}: $-14{\cdot}790 \pm 0{\cdot}030$; P^{31}: $-16{\cdot}378 \pm 0{\cdot}030$; P^{32}: $-15{\cdot}909 \pm 0{\cdot}030$; S^{32}: $-17{\cdot}735 \pm 0{\cdot}030$ (all $\times 10^{-3}$ m.u.).

A. O. STANESBY

539.165/.166

3825. Radiations from radioactive rhodium (105). C. E. MANDEVILLE AND E. SHAPIRO. *J. Franklin Inst.*, **253**, 145–52 (*Feb.*, 1952).

The characteristic radiations of the 36 hr rhodium (105) were investigated with conventional absorption and coincidence methods. The β-rays have a maximum energy of 0·55 MeV and the γ-rays a quantum energy of $\sim 0{\cdot}3$ MeV. The β–γ coincidence rate of Rh^{105} indicated that $< 8\%$ of the β-rays are coupled with the γ-ray. A.

539.165/.166 : 537.542

3826. Use of the scintillation spectrometer in the investigation of nuclear energy levels. W. STEUBER. *Univ. Microfilms, Publ. No.* 2227, 79 *pp.* (1950).

The response of the crystal to γ-rays was analysed in detail, and it was found quite feasible to measure coincidence rates between particular nuclear particles while discriminating against other radiation. Results: Ta^{182}: the 525 keV β-ray leads to the 74 and 101 keV and the 1·121 and 1·189 MeV γ-rays. None of the three high-energy γ-rays (>1 MeV) are in coincidence with the 525 keV β-ray. Ce^{141}: 420 keV β coincides with 145 keV β; 245 keV β coincides with 315 keV γ; the 560 keV β does not coincide with either. Estimates of branching ratios and conversion coeffs. have been made.

MICROFILM ABSTRACTS

539.165

3827. Spectrometer measurement of β-β coincidences. O. HUBER, F. HUMBEL, H. SCHNEIDER AND A. DE SHALIT. *Helv. Phys. Acta*, **25**, 3–34 (*No.* 1–2, 1952) *In German.*

A β–β-coincidence arrangement which uses the high resolving power of a lens spectrometer is described. A scintillation counter is added as a β-detector near the radioactive source of the lens spectrometer. Coincidences are registered between the counts of this detector and the electrons of a chosen energy in the counter of the spectrometer. This arrangement is sufficient for establishing decay-schemes, even though coincidences are measured between a selected electron-line and all other emitted β-radiation. Some applica-

ns are discussed, and the coefficients of the internal nversion of the γ-rays and X-rays are given for ^{198}, In^{111}, Cd^{109}. A.

539.165

28. Beta-spectra of cerium 144 and praseodymium 4. L.-S. Cheng, G. John and J. D. Kurbatov. tter in *Phys. Rev.*, **85**, 487–8 (*Feb.* 1, 1952).

The two isotopes were in equilibrium in carrier-free ed fission product. The β-spectrum of Pr^{144} was 00 MeV (85 ± 5%), 1·30 MeV (12 ± 2%) and 5 keV (3 ± 1%), and that of Ce^{144} 446 keV ± 1%) and 307 keV (97 ± 1%). F. R. HOLT

539.165

29. Concerning the existence of positive particles itted by P^{32}, a β^--ray emitter. T. Yuasa. *C.R. ad. Sci.* [*Paris*] **234**, 619–21 (*Feb.* 4, 1952) *In French.*

They were detected with a Wilson chamber and also th a small 180° magnetic spectrograph. The $^+/N^-$ ratio is between 2×10^{-8} and 2×10^{-7}. F. R. HOLT

539.165

30. The beta-spectrum of RaD. G. M. Insch, G. Balfour and S. C. Curran. *Phys. Rev.*, **85**, 5–7 (*March* 1, 1952).

The electronic radiations from a very thin source RaD are analysed by means of a proportional unter, operating as a 2π spectrometer. The β-rays the continuum which coincide with the photo-ectrons of highest energy form the tail on the pulse stribution which is analysed to isolate the β-particles id to compare their spectrum with Fermi theory. ne disintegration energy is found to be 64·5 ± 5 keV and the limiting energy of the β-rays = 18 ± 5 keV. The form of the spectrum agrees with the eoretical shape for an allowed transition and = 18 keV. The presence of a complex system of ft photoelectron peaks, probably emitted mostly in iscade, is deduced from the remarkable shape of the lse spectrum at low energies (5 to 25 keV). A.

539.165

31. Angular correlation of electrons in double eta-decay. H. Primakoff. *Phys. Rev.*, **85**, 888–90 *March* 1, 1952).

Angular correlation functions for the emitted ectrons with corresponding electron energy spectra re obtained, assuming the Majorana theory of the eutrino, for allowed and first-forbidden nuclear ouble β-transitions. The associated decay mean ves are estimated $\simeq10^{12}$ yr, and $\simeq10^{16}$ yr, respec-vely, for $Z\simeq50$, and an atomic mass difference 1·5 MeV. A brief discussion is given of the ported experimental observations of double β-ecay in the light of the deduced angular correlation nctions, electron energy spectra, decay mean lives nd selection rules; the improbability of actual ccurrence of the allowed 10^{12} yr transitions is pointed ut. A.

539.165 : 539.166

32. Some studies in angular correlation. E. K. ARBY. *Canad. J. Phys.*, **29**, 569–76 (*Nov.*, 1951).

The β–γ-angular correlation in Sb^{124} has been easured as a function of β-energy using a 12-annel kicksorter and a thick crystal counter as β-detector. The differential correlation coefficient $a(E)$ has been found to change from −0·17 at 1 MeV to −0·44 at the end of the β-spectrum. When integrated numerically over all β-energies greater than 1 MeV the integrated angular correlation coefficient so obtained agrees with the value measured directly. Experiments on the γ–γ-angular correlation in Co^{60} and Sc^{46} performed with the same apparatus are in agreement with previous results of other workers. A.

539.165.2

3833. On the nucleon-lepton interaction in the theory of β-disintegration. R. Bouchez and R. Nataf. *C.R. Acad. Sci.* [*Paris*] **234**, 86–8 (*Jan.* 2, 1952) *In French.*

An examination of the matrix elements for allowed transitions for small z ($A < 40$) and comparison with experiment seems to indicate that in addition to ~ 85% tensor or ps. vector interaction there is 15% scalar or vector interaction. W. J. SWIATECKI

539.166

3834. Angular correlation of the γ-γ-cascade of Cd^{111}. H. Aeppli, H. Frauenfelder and M. Walter. *Helv. Phys. Acta*, **24**, 325–6 (*No.* 4, 1951) *In German.*

The observed correlation can be explained by assuming that the second γ-ray is pure electric quadrupole, and the first a mixture of magnetic dipole (α) and electric quadrupole (β). The intensity ratio is $|\beta^2|:|\alpha|^2 = 0\cdot01 \pm 0\cdot003$, and the relative phase 180°. J. HUGHES

539.166

3835. Build-up factors for transmission of Co^{60} gamma-rays through concrete and lead. W. R. Dixon. Letter in *Phys. Rev.*, **85**, 498–9 (*Feb.* 1, 1952).

An experimental study, using a wide beam and thicknesses of up to 40 in of concrete and 22 cm of lead. J. J. WILKINS

539.166 : 535.33

3836. A scintillation spectrometer for high-energy gamma-rays. S. A. E. Johansson. *Phil. Mag.*, **43**, 249–56 (*Feb.*, 1952).

Describes a scintillation spectrometer, which measures the energy of the pairs produced by γ-rays. Each γ-energy gives a symmetric peak in the energy distribution. The width at half-maximum is 7% at 4 MeV. The greatest advantage of this apparatus is the high sensitivity. It has been possible to measure sources with a strength of about 0·1 μc. A.

539.166 : 537.534.8

Proton bremsstrahlung at 140 MeV. *See Abstr.* 3642

539.166 : 778.33

Gamma-ray sources for radiography. *See Abstr.* 4088

539.166.2

3837. On a possible mechanism of nuclear γ-radiation with the participation of neutral mesons. I. S. Shapiro. *Zh. Eksper. Teor. Fiz.*, **21**, 731–6 (*No.* 6, 1951) *In Russian.*

Virtual mesons are emitted by the excited nucleus and subsequently decay. The life-time for electric

quadrupole transitions is estimated at $\sim 10^{-20} \times$ (meson mass $\times c^2/\hbar w)^7$ sec, so that at high energies $\hbar w$ the process is not negligible. W. J. SWIATECKI

539.166.74

3838. The scattering of 0·5-MeV circularly polarized photons in magnetized iron. F. P. CLAY AND F. L. HEREFORD. Letter in *Phys. Rev.*, **85**, 675 (*Feb.* 15, 1952).

Forward Compton electrons, ejected by annihilation quanta from two magnetized Fe foils, were detected in coincidence. Reversal of the magnetization of either foil produced about 3·5% change in coincidence rate. J. J. WILKINS

539.166.74

3839. Multiple Compton scattering of low energy gamma-radiation. R. C. O'ROURKE. *Phys. Rev.*, **85**, 881–8 (*March* 1, 1952).

Contains solutions to several problems of multiple Compton scattering of low-energy γ-radiation ($E \ll \frac{1}{2}$ MeV). The results have been obtained by an approximate method proposed by Chandrasekhar. The solutions indicate an appreciable broadening of a primary monochromatic spectral distribution after it has passed through relatively small distances in the scattering medium. The results for the forward scattering spectral distributions exhibit small shifts to the violet because of an approximation employed (viz. a Taylor series development). Chandrasekhar proposed that the area of this violet shift be used as a criterion of error. If this is accepted, then the error is less than 15% at a distance of $x = 1$ and decreases rapidly with increasing x. The corresponding results for the backscattering spectral distributions exhibit negative intensities near the source, i.e. for small x. Again the area of this negative portion of the spectral distribution curves becomes negligible as x increases. It requires a great deal of graphical integration to plot the results for the backscattering in the plane parallel media over the required range of wavelength shifts, which is some 20–30 Compton units. One can exhibit the negative intensities, however, by plotting the results over a range of zero to about 5 Compton units. In the case of a point source in an infinite spherical medium the backscattering spectral distribution was obtained in closed form. The method of Chandrasekhar seems to yield qualitatively correct results if only distances x which are greater than about $x = 2$ are used. If an attempt is made to include either the higher derivatives in the Taylor series or to go to the higher approximations of the Gauss and Radau methods, or both, there results a system of partial differential equations of high order which cannot be solved by any practical method. A.

539.166.83

3840. A note on the intensities of the internal conversion lines of the three intense γ-rays of RaB. S. KAGEYAMA. *J. Phys. Soc. Japan*, **6**, 285–9 (*Sept.–Oct.*, 1951).

The relative intensities of internal conversion electrons of 240, 294 and 350 keV γ-rays of RaB and ratios of those for K and L energy levels, α_K/α_L, have been investigated with a magnetic spectrometer of fair resolution and G.M. counter technique. Values of α_K obtained are in accord with the results of Ellis and Aston, but those of α_L and α_M are slightly different from their values. The agreement between observed and theoretical values of α_K/α_L is satisfactory within the experimental error. A.

539.166.835

3841. The Z-dependence of the cross-section for pair production by Ra γ-rays. B. HAHN, E. BALDINGER AND P. HUBER. *Helv. Phys. Acta*, **24**, 324–5 (*No.* 4, 1951). *In German.*

Measurements made on 10 elements, of which Fe was the lightest and U the heaviest, showed good agreement with the calculated values of Jaeger and Hulme. J. HUGHES

539.166.835

3842. A demonstration experiment on positron annihilation. J. S. LEVINGER. *Amer. J. Phys.*, **20**, 71–2 (*Feb.*, 1952).

A lecture demonstration on positron annihilation is discussed. Using two small Geiger counters and a standard Rossi coincidence circuit, it was possible to demonstrate that the two annihilation photons go in opposite directions. A special arrangement of lead shielding is suggested. A.

539.166.835 : 539.153

3843. Three-quantum annihilation and positronium. S. DE BENEDETTI AND R. SIEGEL. Letter in *Phys. Rev.*, **85**, 371–2 (*Jan.* 15, 1952).

Triple coincidences of coplanar scintillation counters at 0°, 120°, 240° were observed from positrons stopped in (*a*) a solid, (*b*) a small freon container. A study of the pulse height distribution reveals the expected peak at $\frac{2}{3}\,mc^2$. W. J. SWIATECKI

539.166.835 : 539.153

3844. The half-life of positrons in condensed materials. S. DE BENEDETTI AND H. J. RICHINGS. Letter in *Phys. Rev.*, **85**, 377–8 (*Jan.* 15, 1952).

The difference in the $\frac{1}{2}$-lives in several pairs of materials was studied using delayed coincidences between the nuclear γ-rays of Na^{22} and the annihilation radiation from the positrons. All metals tested showed the same $\frac{1}{2}$-life. There may be evidence for the formation of positron compounds. W. J. SWIATECKI

539.166.835 : 539.153

3845. The formation of triplet positronium in gases. T. A. POND. Letter in *Phys. Rev.*, **85**, 489 (*Feb.* 1, 1952).

The proportion of 3-photon decays of Na^{22} positrons in H_2, N_2, A and He was measured in a mean field of 5 280 gauss. J. J. WILKINS

539.166.835 : 539.153

3846. Fine structure splitting in the ground state of positronium. T. A. POND AND R. H. DICKE. Letter in *Phys. Rev.*, **85**, 489–90 (*Feb.* 1, 1952).

The proportion of 3-photon decays of positrons in N_2 has been studied as a function of magnetic field, up to 6 280 gauss. Confirmation of the theoretical fine structure splitting is deduced. J. J. WILKINS

539.167.3

3847. Carrier-free radioisotopes from cyclotron targets. XXVI. Preparation and isolation of W^{181} from tantalum. J. D. GILE, W. M. GARRISON AND J. G. HAMILTON. Letter in *J. Chem. Phys.*, **20**, 523–4 (*March*, 1952). For Pt XXV, see Abstr. 2970 (1952).

539.167.3

3848. On the history of the discovery of artificial radiation. R. FLEISCHMANN. *Naturwissenschaften*, 38, 465–7 (*No.* 20, 1951) *In German.*

Brief survey with over 24 references.

539.167.3

3849. Preparation of Ra^{229} and Ac^{229}. F. DEPOCAS AND B. G. HARVEY. Letter in *Phys. Rev.*, **85**, 499–500 (*Feb.* 1, 1952).

By irradiation of separated Ra^{228}(MsTh1) in an intense thermal neutron flux, a β-activity of $\frac{1}{2}$-life 5 ± 5 min was obtained (calc. energy $\sim 0{\cdot}9$ MeV) and attributed to Ac^{229} formed via Ra^{229} (of calc. γ-energy $\sim$2 MeV and $\frac{1}{2}$-life $\sim$1 min). A. O. STANESBY

NUCLEAR REACTIONS 539.17

539.17

3850. The abundance distribution of elements. L. S. SINGWI AND B. K. AGARWALA. *Proc. Nat. Inst. Sci. India*, **17**, 425–36 (*Nov.–Dec.*, 1951).

The thermodynamic equilibrium of a simplified assembly consisting of neutrons, protons, electrons, positrons and α-particles is considered; account is also taken of the degeneracy of the electrons and the presence of the neutrinos. Asymptotic expressions are derived for the neutron ν. proton concentration in the two limiting cases of (i) non-degeneracy and (ii) degeneracy of electrons. Next, the thermodynamic equilibrium of the assembly in which all elements are present is considered, and account is also taken, in the equilibrium equations, of the partition function factors of the excited states of nuclei. It is found that the effect of including all the nuclei in the assembly is to bring about a more rapid fall of the proton concentration (beyond the proton maximum) with increasing neutron concentration than is given by the considerations of the simplified assembly. The method of Darwin and Fowler is used throughout. The relative abundances of elements for the temperature $T = 8 \times 10^9$ degrees are computed; the computed abundance curve agrees fairly satisfactorily with the empirical curve of Goldschmidt for elements up to mass number 70 under the conditions: $T = 8 \times 10^9$ deg., Log $n_0 = 30{\cdot}0$, Log $n_p = 29{\cdot}1$ with the exception of the elements Sc, V and Ti. The equilibrium theory fails completely to account for the abundances of heavy elements. Finally, the authors derive the "Zustände" for the higher rotational and vibrational states of the nuclei. A.

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 3690

539.172

3851. Some features of nuclear disintegrations caused by cosmic rays. P. E. HODGSON. *Phil. Mag.*, **43**, 190–200 (*Feb.*, 1952).

Cosmic-ray stars in light and heavy elements have been investigated by the photographic plate method. The angular distribution of the particles from stars in heavy elements is shown to be isotropic, while that of those from light elements is not. Possible explanations of this are discussed. The numbers of stars with various numbers of α-particles and protons are shown to be in accordance with a random distribution. This indicates that the emission of one charged particle has no influence on the nature of a subsequent charged particle. The emission of excited Be^8 nuclei is also investigated and their frequency found to agree with the evaporation theory. A.

539.172

3852. The interaction of fast π-mesons with nuclei. W. O. LOCK AND G. YEKUTIELI. *Phil. Mag.*, **43**, 231–48 (*Feb.*, 1952).

A study has been made of the nuclear disintegrations produced by π-mesons of energy between 50 and 1 100 MeV, and they have been compared with those produced by protons of energy up to 800 MeV. The results are consistent with the hypothesis that a π-meson commonly interacts with a complex nucleus by making two or more elastic collisions with its nucleons. By studying the characteristics of the meson "stars," estimates have been obtained of the relative probabilities of the meson being absorbed in a nuclear collision, of undergoing charge exchange, or of being elastically scattered. A.

539.172

3853. Nuclear cross sections for negative pions of energy 109 and 133 MeV. R. L. MARTIN, H. L. ANDERSON AND G. YODH. Letter in *Phys. Rev.*, **85**, 486–7 (*Feb.* 1, 1952).

These were deduced from quadruple coincidences of two pairs of counters placed in meson beams and with C, Al, Cu, Cd, Sn or Pb absorbers inserted between the pairs. Geometric cross-sections were found within 15%. With the possible exception of C there is no energy dependence from 85 to 133 MeV. W. J. SWIATECKI

539.172

3854. Disintegration of the deuteron by π^+ mesons and the spin of the π^+ meson. D. L. CLARK, A. ROBERTS AND R. WILSON. *Phys. Rev.*, **85**, 523–9 (*Feb.* 15, 1952).

The total cross-section for the reaction $\pi^+ + d \rightarrow p + p$ has been measured for an average incident meson energy of 23 MeV. This corresponds to a proton energy of 340 MeV in the inverse reaction $p + p \rightarrow \pi^+ + d$, for which the total cross-section has been measured by Richman, Cartwright, Peterson and others. Comparison of these two cross-sections, using the theorem of detailed balancing, leads to a determination of the statistical weight, and hence the spin, of the π^+ meson. The spin turns out to be zero. A.

539.172.13

3855. The excitation curve of the reaction $C^{13}(p, n)N^{13}$. C. EGGENBERGER AND P. MARMIER. *Helv. Phys. Acta*, **24**, 323 (*No.* 4, 1951) *In German.*

This was measured, using the stacked foil technique, from the threshold at 3·23 MeV to 6·8 MeV. Resonances were found at proton energies of 4·1, 4·9 and 6·3 MeV. J. HUGHES

539.172.13

3856. Inelastic cross sections for 240-MeV protons. A. M. PERRY, JR. Letter in *Phys. Rev.*, **85**, 497–8 (*Feb.* 1, 1952).

99 m of tracks in nuclear emulsions were inspected

at 600×magnification. A mean-free path in nuclear matter depending on the energy of the proton, but the same for all nuclei, was assumed. It was measured as 36 cm for inelastic collisions in emulsion. Cross-sections were: Ag $1{\cdot}18 \pm 0{\cdot}08$, Br $0{\cdot}97 \pm 0{\cdot}07$, O $0{\cdot}25 \pm 0{\cdot}03$, N $0{\cdot}23 \pm 0{\cdot}03$ and C $0{\cdot}21 \pm 0{\cdot}03$ barns. F. R. HOLT

539.172.13

3857. The reaction $Be^9(p, \alpha\gamma)Li^6$. R. B. Day and R. L. Walker. *Phys. Rev.*, **85**, 582–5 (*Feb.* 15, 1952).

The energy of the γ-radiation produced when Be^9 is bombarded by 2·6 MeV protons has been measured with a scintillation spectrometer and found to be $3{\cdot}58 \pm 0{\cdot}04$ MeV. A suggestion of Hushley that this γ-ray is produced in the reaction $Be^9(p, \alpha\gamma)Li^6$ was verified by observing coincidences between the γ-rays and low energy α-particles. The excited state of Li^6 which emits the γ-rays probably has spin zero and even parity and is presumably the analogue of the ground state of the isobaric nucleus, He^6. The thick target yield and cross-section at resonance were found to be $4{\cdot}8 \times 10^{-7}$ γ-rays per proton and $0{\cdot}11 \times 10^{-24}$ cm², respectively. A.

539.172.13

3858. The (p, n) reaction on separated isotopes of chromium. J. A. Lovington, J. J. G. McCue and W. M. Preston. *Phys. Rev.*, **85**, 585–9 (*Feb.* 15, 1952).

Several hundred resonances have been observed in the neutron yield from proton bombardment of the enriched isotopes Cr^{53} and Cr^{54}. No characteristic groups of resonances are observed. Upper limits to the level spacing in the compound nuclei Mn^{54} and Mn^{55} are 4 and 5 keV, respectively. The thresholds are found to be $1\,406 \pm 8$ keV for $Cr^{53}(p, n)$ and $2\,202 \pm 5$ keV for $Cr^{54}(p, n)$. A.

539.172.13

3859. The yield of gamma-rays and neutrons from the proton bombardment of fluorine. H. B. Willard, J. K. Bair, J. D. Kington, T. M. Hahn, C. W. Snyder and F. P. Green. *Phys. Rev.*, **85**, 849–51 (*March* 1, 1952).

The excitation function of γ-rays produced by the proton bombardment of F has been extended from 2·1 to 5·4 MeV with a resolution of 0·1%. 17 new resonances were observed with maxima at 2·32, 2·51, 2·63, 2·80, 3·02, 3·19, 3·49, 3·92, 4·00, 4·29, 4·49, 4·57, 4·71, 4·78, 4·99, 5·07 and 5·20 MeV. The $F^{19}(p, n)Ne^{19}$ threshold was determined to be $4{\cdot}253 \pm 0{\cdot}005$ MeV, and the neutron yield in the forward direction was extended to 5·3 MeV. Maxima occur at 4·29, 4·46, 4·49, 4·57, 4·62, 4·71, 4·78, 4·99, 5·07 and 5·20 MeV. The Ne^{19}—F^{19} mass difference was calculated from the threshold measurement to be $0{\cdot}00349_9$ a.m.u. A.

539.172.13

3860. The reaction $Cl^{37}(p, n)A^{38}$; excited states in A^{38}. W. A. Schoenfeld, R. W. Duborg, W. M. Preston and C. Goodman. *Phys. Rev.*, **85**, 873–6 (*March* 1, 1952).

The relative neutron yield of the reaction $Cl^{37}(p, n)A^{37}$ has been observed from the threshold, at $1\,641 \pm 2$ keV, up to a proton energy of 2 510 keV. Over 100 resonances are found; these correspond to excited states in the compound nucleus A^{38}, with an average separation of about 5 keV. A.

539.172.13 : 539.172.4

3861. On the demonstration of a difference between light and heavy nuclei in charge exchanges of very fast nucleons. P. Cüer and J. Combe. *C.R. Acad. Sci.* [*Paris*] **234**, 82–4 (*Jan.* 2, 1952) *In French.*

Observations on nuclear emulsion stars produced by 90 and 270 MeV neutrons and by 340 MeV protons are described. About 50% of the nucleons incident on heavy nuclei (Ag, Br) undergo charge exchange before re-emerging, whereas for light nuclei (C, N, O) the proportion is only ~10%. This discrepancy, together with other recent results [Abstr. 4705, 9690 (1951)] lends support to a previous hypothesis of "instantaneous clusters" in light nuclei [Abstr. 3788 (1951)]. J. J. WILKINS

539.172.13 : 539.172.4

3862. Interactions of high energy nucleons with nuclei. I. G. Bernardini, E. T. Booth and S. J. Lindenbaum. *Phys. Rev.*, **85**, 826–34 (*March* 1, 1952).

Goldberger attempted to explain the interaction of high-energy nucleons (~90 MeV) with heavy nuclei on the basis of a nucleonic cascade in a nucleon Fermi gas. The experimental test of this model was indecisive. In order to check the model at higher energies, the interactions of 300–400 MeV protons and neutrons with the G-5 emulsion nuclei were analysed. The experimental results are given and general evidence for the nucleonic cascade mechanism is presented. A.

539.172.13

3863. Considerations regarding the distribution of radiation damage in matter bombarded by light ions and a method of making it uniform. P. Schwed and G. Groetzinger. *J. Appl. Phys.*, **23**, 234–6 (*Feb.*, 1952).

If a beam of high-energy particles impinges on a solid, radiation damage is produced only in a very thin layer at the end of the range of the particles. Computations determining the extent of this inhomogeneity of damage are outlined and carried out for the specific case of 20 MeV deuterons impinging on a copper sample. A simple method is discussed for producing uniform damage in a thickness corresponding to the range of the particles. A.

539.172.13

3864. On the state of polarization of the products of the reaction D + D. M. Cini. Letter in *Nuovo Cim.*, **8**, 1007–10 (*Dec.*, 1951) *In Italian.*

It is shown how experiments in this field may yield useful information on nuclear forces and phase shifts. L. PINCHERLE

539.172.13

3865. Evidence for the excited states of Be^8 and Li^7 in the disintegration of beryllium by deuterons. P. Cüer and J. J. Jung. *C.R. Acad. Sci.* [*Paris*] **234**, 204–6 (*Jan.* 7, 1952) *In French.*

From a detailed examination of the disintegration products from Be^9 bombarded by 0·3 to 1·5 MeV

uterons, the reaction $Be^9(d, t)Be^{8*}$, $Be^{8*} \rightarrow 2\alpha$, $_{c} \sim 3$ MeV, and the appreciable production of *, $E_{exc} \sim 4{\cdot}65$ MeV, were found. In the last e the transition $Li^{7*} \rightarrow t + \alpha$, was established.

J. HUGHES

539.172.13 : 539.155

Determination of the atomic mass of phosphorus by a clear reaction method. *See Abstr.* 3804

539.172.3

56. The solution of X-ray activation curves for otonuclear cross sections. L. KATZ AND A. G. W. MERON. *Canad. J. Phys.*, **29**, 518–44 (*Nov.*, 1951).

A method is presented for the computation of otonuclear cross-sections from their X-ray activa-n or yield curves. It is based on the photon ferences between successive Schiff representations bremsstrahlung spectra and assumes that the tivation curves have smooth first and second rivatives. Artificially prepared activation curves ve been satisfactorily solved by this method, and e published photonuclear activation curves deter-ined in this laboratory have been reanalysed. ie resulting cross-section curves are in essential reement with those originally determined; however, e new values are believed to be more reliable. ew constants for two proposed relationships between , *n*) "resonance" peak energies and atomic mass mber have been determined. Appended to the per are tables of the Schiff bremsstrahlung spectra r maximum photon energies between 8 and 28 MeV d also of special functions for cross-section com-tations between the same energies. A.

539.172.3

367. Photofission of C^{12} into 3 α-particles by γ-rays to 32 MeV. M. EDER AND V. L. TELEGDI. *Helv. hys. Acta*, **25**, 55–78 (*No.* 1–2, 1952) *In German.*

The reaction $C^{12} + h\nu = 3\,He^4$ has been further vestigated in photographic emulsions. By using the remsstrahlung from a 32 MeV betatron it could be onclusively shown that the cross-section reincreases rongly after the known resonance-like peak at ~18 MeV, and some indications of a second maximum round 26 MeV have been obtained. Analysing the nergy-distribution of the α-particles, it has been emonstrated that a rather radical change in the mech-nism is responsible for this reincrease; Be^8 in the xcited state at $E^* = 3{\cdot}0$ MeV does not participate n more than about one-third of the disintegrations nduced by γ-rays above ~19 MeV. The participa-ion of Be^8 in its ground state appears to increase ontinuously with energy and this is regarded as vidence that this state has an intrinsic angular omentum zero, assuming that the excited state at MeV has $J = 2$, which is supported by other vidence. A.

539.172.3

868. (γ, *n*) reactions. A. LATASTE. *J. Phys. Radium*, **13**, 39–45 (*Jan.*, 1952) *In French.*

A review of the principal published data (to April, 951) on (γ, *n*) reactions, also covering allied data on *n*, 2*n*), (γ, *p*) and some multiple reactions, such as *p*, 2*p*). J. J. WILKINS

539.172.3

3869. Remarks on the photodisintegration of some light elements. R. CHASTEL. *C.R. Acad. Sci.* [*Paris*] **234**, 318–20 (*Jan.* 14, 1952) *In French.*

It is suggested that several photodisintegration reactions, e.g. $B^{11}(\gamma, t2\alpha)$, $O^{16}(\gamma, 4\alpha)$, may be "tri-partition" or "quadripartition" processes [see Abstr. 2995 (1952)]. J. J. WILKINS

539.172.3

3870. Photoproduction of neutral mesons from deuterium. W. HECKROTTE, L. R. HENRICH AND J. V. LEPORE. Letter in *Phys. Rev.*, **85**, 490–1 (*Feb.* 1, 1952).

Theoretical differential cross-sections are given, assuming deuteron formation in the final state. The total cross-section (but not the angular distribution) is strongly dependent on the algebraic signs of the couplings to proton and neutron. J. J. WILKINS

539.172.3

3871. Elastic photoproduction of π^0-mesons in deuterium. N. C. FRANCIS AND R. E. MARSHAK. Letter in *Phys. Rev.*, **85**, 496–7 (*Feb.* 1, 1952).

Differential cross-sections are calculated for $\gamma + (p, n \text{ or } d) = (p, n \text{ or } d) + \pi^0$, assuming the nucleon anomalous moments to be responsible for the process through their couplings with the electro-magnetic field. A large difference between "sym-metrical" and "neutral" theories is found.

W. J. SWIATECKI

539.172.3

3872. Neutron yield from the nuclear photoeffect. J. S. LEVINGER AND H. A. BETHE. *Phys. Rev.*, **85**, 577–81 (*Feb.* 15, 1952).

The yields of neutrons produced in photonuclear reactions by a bremsstrahlung-photon-spectrum are analysed in terms of the multiplicity of neutron production. Approximating the neutron multiplicity as proportional to the photon energy, the inte-grated photonuclear cross-section is derived from the experimental neutron yields. The integrated cross-section from copper to bismuth is $\int_0^\infty \sigma dW = 0{\cdot}14NZ/A$. (Uranium has a neutron yield 35% higher than given by this relation, probably due to photo-fission.) This relation has the correct form, but a somewhat higher absolute value than the theoretical relation $\int_0^\infty \sigma dW = 0{\cdot}060(ZN/A)(1 + 0{\cdot}8x)$, where x is the fraction of exchange force. A.

539.172.3

3873. Comparison of total photoneutron yield from 160- and 320-MeV bremsstrahlung. L. W. JONES AND K. M. TERWILLIGER. Letter in *Phys. Rev.*, **85**, 686 (*Feb.* 15, 1952).

For 9 target elements, the yields obtained at 320 MeV were about 30% higher than at 160 MeV, when normalized to equal numbers of quanta below 30 MeV.

J. J. WILKINS

539.172.4

3874. Total effective cross-sections for Be, C, N and Na for fast neutrons from 2 to 3·7 MeV. R. RICAMO AND W. ZÜNTI. *Helv. Phys. Acta*, **24**, 302 (*No.* 4, 1951) *In German.*

The previously reported [Abstr. 1324 (1951)]

equipment has been improved. Be has a broad unsymmetrical maximum of 3·3 barn at 2·75 MeV; C a new peak of 2·4 barn, 50 keV half-width at 2·08 MeV; N has maxima at 2·22, 3·1 and 3·55 MeV; and Na has a complicated structure, with abrupt changes, between 2·0 and 3·4 barn. F. R. HOLT

539.172.4

3875. **(n, α) reaction in O^{16}.** P. HUBER, E. BALDINGER AND W. G. PROCTOR. *Helv. Phys. Acta*, **24**, 302–4 (*No.* 4, 1951) *In German.*

An ionization chamber was filled with 2 atmospheres oxygen and a 19-channel pulse spectrograph was used. The energy of the reaction products was measured as $1·71 \pm 0·02$ MeV, and the Q-value was $2·38 \pm 0·16$ MeV. F. R. HOLT

539.172.4

3876. **Study of the neutron collision cross-section of lithium.** P. VERZAUX. *J. Phys. Radium*, **13**, 21–7 (*Jan.*, 1952) *In French.*

Theoretical calculations show that for slow neutrons the observed cross-section is due mainly to Li^6, whereas for energies around 270 keV the scattering is mainly due to a resonance in Li^7, and capture to a resonance in Li^6. W. J. SWIATECKI

539.172.4

3877. **Some experimental work carried out in physics with the larger Harwell pile.** *Nature* [*Lond.*] **168**, 581–3 (*Oct.* 6, 1951).

Describes some of the work carried out at A.E.R.E. on neutron crystallography, the effects of pile irradiation on materials, the measurement of cross-sections for nearly monoenergetic neutrons, the use of "cold" neutrons, the measurement of the angular correlation between particles emitted in nuclear processes and the use of gridded ionization chambers for various purposes. J. THEWLIS

539.172.4

3878. **The joint Dutch-Norwegian nuclear reactor at Kjeller near Oslo.** J. J. WENT. *Electro-techniek*, **30**, 49–56 (*Feb.* 14, 1952) *In Dutch.*

Gives a general description of the new 100 kW heavy water uranium reactor ("Jeep") recently opened in Norway. The construction, control and aims of the reactor are indicated. E. P. WOHLFARTH

539.172.4

3879. **Fission neutron spectrum of U^{235}.** N. NERESON. *Phys. Rev.*, **85**, 600–3 (*Feb.* 15, 1952).

The energy distribution of neutrons (prompt and delayed) arising from thermal fission of U^{235} has been studied with nuclear plates. The spectrum obtained shows a maximum in the region of 0·7–0·8 MeV and an exponential slope of $3·9 \pm 0·2$ MeV per decade of intensity in the energy region above 2 MeV. The data extend over the energy range from 0·4 to 7 MeV. A.

539.172.4

3880. **A determination of the rate of emission of spontaneous fission neutrons by natural uranium.** D. J. LITTLER. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 203–8 (*March*, 1952).

By comparison with a calibrated neutron source, the total rate of emission of primary neutrons in the Graphite Low Energy Experimental Pile has been found. The rate of emission of spontaneous fission neutrons from natural U is computed to be $59·5 \pm 3·3$ neutrons/g/hr of U. A.

539.172.4

3881. **The thermal exploitation of nuclear energy.** J. L. D'EPINAY. *Schweiz. Bauztg*, **70**, 91–7 (*Feb.* 16, 1952) *In German.*

Gives a brief description of nuclear reactors already in use and describes the plans for building a reactor in Switzerland. E. P. WOHLFARTH

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

3882. **Experimental determination of the energy spectrum of the electron from the disintegration of the μ meson.** A. LAGARRIGUE AND C. PEYROU. *J. Phys. Radium*, **12**, 848–53 (*Nov.*, 1951) *In French.*

This was done by means of a cloud chamber in a magnetic field and an anti-coincidence circuit arranged to photograph mesons stopped in graphite layers and their decay electrons. Good agreement was found with similar experiments of Leighton, Anderson and Seriff [Abstr. 4870 (1949)] and with a theoretical spectrum from L. Michel [Abstr. 5516 (1950)] for the decay into an electron and 2 neutrinos. W. J. SWIATECKI

539.18

3883. **Continuous γ-radiation accompanying the disintegration of the μ meson.** A. ABRAGAM AND J. HOROWITZ. Letter in *J. Phys. Radium*, **12**, 952–3 (*Dec.*, 1951) *In French.*

The cross-section and angular distribution for the process $\mu^{\pm} \rightarrow e^{\pm} + \nu + \nu + \gamma$ is calculated using a simple perturbing Hamiltonian. The mean photon energy is of the order of $3·3 \times 10^{-3}$ times the meson rest mass. W. J. SWIATECKI

539.18

3884. **A probable example of multiple production of mesons.** M. DEMEUR, C. DILWORTH AND M. SCHÖNBERG. *Nuovo Cim.*, **9**, 92–4 (*Jan.*, 1952).

An analysis of the 7 prongs of a star (produced by a neutral primary) observed in an Ilford G5 emulsion in a field of 22 000 gauss does not agree with the theories of either Fermi [Abstr. 3336 (1951)], Heisenberg [Abstr. 9010 (1950)] or Wataghin [Abstr. 4990 (1950)]. W. J. SWIATECKI

539.18

3885. **Charged π-meson production from deuterium.** S. PASSMAN, M. M. BLOCK AND W. W. HAVENS, JR. Letter in *Phys. Rev.*, **85**, 370–1 (*Jan.* 15, 1952).

The cross-sections for $\pi^{\pm}$ from D at $90° \pm 5°$ to a 381 MeV proton beam were obtained by a photographic plate method and agree with an "impulse approximation" calculation of the process $p + p \rightarrow \pi^{+} + d$ (or $p + n$). W. J. SWIATECKI

539.18

3886. **Neutral V-particle decay and the negative proton.** L. I. SCHIFF. Letter in *Phys. Rev.*, **85**, 374 (*Jan.* 15, 1952).

The observed presence of the process $V^0 \rightarrow P^+ + \pi^-$

t the absence of $V^0 \rightarrow P^- + \pi^+$ could be explained assuming that there is a conservation law for otons, neutrons and V^0 stating that in any process difference between the total number of such rticles and their antiparticles is a constant of the otion. W. J. SWIATECKI

539.18

87. Antiproton annihilation. I. REFF. Letter in *ys. Rev.*, **85**, 379 (*Jan.* 15, 1952).

The total and differential cross-sections for meson oduction by proton-antiproton annihilation were aluated by perturbation method for all types of esons and couplings. W. J. SWIATECKI

539.18

88. On the energy loss of fast mesons due to pair oduction. M. MANDÒ AND L. RONCHI, JR. *Nuovo m.*, **9**, 105–15 (*Feb.*, 1952) *In Italian.*

This was calculated on the basis of formulae for the oss-section established by Racah (1937). For μ-esons: $-(dE/dx)_{\text{pairs}} = NCpE(19{\cdot}3 \ln \xi_0 - 53{\cdot}7)/A$ here N = Avogadro's number; A = average at. w. the material; $C = Z^2Z'^2\alpha^2r_0^2/\pi$ (Z = charge of the om, Z' = charge of the meson); $p = m/M$; E = ergy of meson; ξ_0 = Lorentz factor of meson. he screening effect reduces the r.h.s. by a factor 0·7. L. PINCHERLE

539.18

89. Total cross sections of 60-MeV mesons in drogen and deuterium. P. J. ISAACS, A. M. SACHS ND J. STEINBERGER. *Phys. Rev.*, **85**, 803–5 (*March* 1, 52).

The total cross-sections of positive and negative esons of average energy 58 MeV have been measured hydrogen and deuterium. The results are $\sigma(\pi^+ + p) = 27{\cdot}8 \pm 2{\cdot}5$ mb, $\sigma(\pi^- + p) = 17{\cdot}6 \pm 2$ mb, $\sigma(\pi^+ + d) = 38{\cdot}3 \pm 3{\cdot}1$ mb, $\sigma(\pi^- + d) = 2{\cdot}8 \pm 3{\cdot}1$ mb. The deuteron cross-sections are lated to the elementary scattering amplitudes in the mpulse approximation, and the observed interference compared to that predicted in weak coupling meson eory. A.

539.185

90. On the theory of the scattering of neutrons y protons. T. SEXL. Note in *Naturwissenschaften*, **3**, 454–5 (*No.* 19, 1951) *In German.*

A derivation of the "Fermi scattering length" and he "effective range" from the early formalism of . Guth and T. Sexl [*Z. Phys.*, **66**, 557 (1930). W. J. SWIATECKI

539.185

91. Scattering of fast neutrons by O^{16}. E. ALDINGER, P. HUBER AND W. G. PROCTOR. *Helv. hys. Acta*, **25**, 142–52 (*No.* 1–2, 1952) *In German.*

The differential cross-sections for the scattering of eutrons by O^{16} have been measured at various nergies between 2 and 4 MeV, using an ionization namber. These data, together with the known otal cross-section, permit an analysis to be made or the partial wave phases responsible for the cattering. The analysis shows that four levels, with uitable potential scattering, are responsible for the bserved total and differential cross-sections. A.

539.185

3892. The coherent neutron scattering cross section of C^{13}. W. C. KOEHLER AND E. O. WOLLAN. Letter in *Phys. Rev.*, **85**, 491–2 (*Feb.* 1, 1952).

The isotopic incoherence due to the presence of C^{13} in normal carbon was found to be less than 1 millibarn. The spin-incoherent scattering is also very small. W. J. SWIATECKI

539.185

3893. Neutron scattering lengths. D. C. PEASLEE. *Phys. Rev.*, **85**, 555–8 (*Feb.* 15, 1952).

The schematic treatment of nuclear reactions is applied to the case $E_n \rightarrow 0$ as a means of interpreting measurements of the scattering length a. It is found that the quantity $\Delta = (a - R)$ rather than a is significant for determining the resonance properties of the compound nucleus, where R is the phenomenological nuclear radius. In some cases this treatment can resolve ambiguity in the evaluation of a without the necessity of polarization measurements and assign the J value of a low-lying resonance or two, but it can only be used successfully for separated isotopes. For practically pure isotopes it can be used to determine rough values of level spacing D from the measured position of the levels nearest $E_n = 0$, or conversely. Values of D obtained in this way are plotted against A to yield an estimate of a parameter in the statistical formula for level density; this estimate suggests a somewhat more rapid increase in level spacing with decreasing excitation than given by the simplest statistical formula. A.

539.185

3894. Neutron transmission cross sections in the kilovolt region. C. T. HIBDON, A. LANGSDORF, JR AND R. E. HOLLAND. *Phys. Rev.*, **85**, 595–600 (*Feb.* 15, 1952).

Neutron transmission cross-sections have been measured with about 2 keV resolution in the energy range from 2 keV to 25 keV, and to higher energies in some case. The neutrons, produced by the $Li^7(p,n)Be^7$ reaction with a van de Graaff generator, were detected by a highly efficient (~15%) bank of BF_3-filled proportional counters placed to detect neutrons emitted at an angle of 120° from the proton beam direction. Measurements at the lower energies were made possible by a collimator and shield around the counters, which reduced background, and by the high efficiency obtained by many counters embedded in an array in a paraffin moderator. Resonances were observed in Na, Ti, V, Mn, Fe, Co and Ni. A.

539.185

3895. On neutron diffraction phenomena according to the kinematical theory. I. I. WALLER AND P. O. FRÖMAN. *Ark. Fys.*, **4**, 183–9 (*Paper* 5, 1952).

Discusses the diffuse temperature scattering of slow neutrons when the Laue interference conditions are approximately satisfied. The methods used are similar to those developed by Waller in the corresponding theory for X-rays, no account being taken of spin-dependent interactions. Two cases are discussed, in which the incident neutron velocity is greater and smaller respectively than the speed of sound (assumed to be independent of direction) in the crystal. J. THEWLIS

539.185

3896. On neutron diffraction phenomena according to the kinematical theory. II. P. O. Fröman. *Ark. Fys.*, **4**, 191–202 (*Paper* 6, 1951).

An extension and generalization of the ideas expressed in Pt I. J. THEWLIS

539.185 : 535.43 : 537.531

Geometrical optics and the theory of multiple small angle scattering. *See Abstr.* 3622

539.185 : 537.122

3897. A measurement of the electron-neutron interaction. M. Hamermesh, G. R. Ringo and A. Wattenberg. Letter in *Phys. Rev.*, **85**, 483 (*Feb.* 1, 1952).

A refinement of the method of Fermi and Marshall [Abstr. 1075 (1948)] gave 4 100 ± 1 000 eV for the depth of an *e–n* interaction well whose radius is the electron radius. W. J. SWIATECKI

539.185.7

3898. On the variation of absorption of a beam of neutrons as a function of the geometrical conditions. G. Stiennon. *Bull. Soc. Roy. Sci. Liège*, **20**, 667–74 (*Nov.*, 1951) *In French.*

The number of neutrons from a finite source detected by a finite detector after passing through an absorber of known thickness is calculated. Results are compared with experiment, using methods previously described [*Bull. Soc. Roy. Sci. Liège*, **19**, 550–60 (*No.* 12, 1950)]. F. R. HOLT

539.185.7

3899. Study of minerals of the rare earths by neutron absorption. I. H. Ford and E. E. Picciotto. *Nuovo Cim.*, **9**, 141–4 (*Feb.*, 1952) *In French.*

Thin sections (30 μ to 1 mm) of minerals were placed over a B-loaded nuclear plate, and exposed to thermal neutrons, from a 1 curie Ra–Be source, slowed down in 1 m of water. Sm and Gd in the minerals screen the plates. F. R. HOLT

STRUCTURE OF SOLIDS 539.2

539.21

3900. A physical theory of rubber reinforcement. A. M. Bueche. Letter in *J. Appl. Phys.*, **23**, 154–5 (*Jan.*, 1952).

The theory suggested is based on the assumption that (1) the number of points of adherence between filler and polymer is proportional to the filler surface, (2) the filler particles are spherical, (3) the points of adherence are added at random, and (4) a molecule will contribute to the elasticity only when it has not less than two points of adherence; one of the results of the theory is that the magnitude of the filler effect is determined by the quotient f/r (number of points of adherence/particle radius); the surface area necessary for one point of adherence, calculated from available data, is of the expected order of magnitude (a few Å^2). F. LACHMAN

539.215.2 : 539.27

3901. On the electron microscope structure of the graphitic and temper carbon in cast iron. H. Sawamura. *Mem. Fac. Engng Kyoto Univ.*, **13**, 209–12 (*Oct.*, 1951).

Graphite particles extracted from cast iron were measured and found to be so much larger than the X-ray particle size that they must be coagulates of graphite crystallites. R. S. PEASE

539.215.4 : 542.65

3902. The observation of the precipitation process by electron microscope. I. Barium sulfate. S. Okada, M. Kawane and S. Magari. *Mem. Fac. Engng Kyoto Univ.*, **13**, 198–208 (*Oct.*, 1951).

The dimensions and constitution of particles of $BaSO_4$ produced under various conditions of precipitation were observed. The size of the initial particles is about 1 000 Å; these are oriented and coagulated into particles of size greater than 1 μ. R. S. PEASE

539.215.7

3903. Orientation of crystallites in stretched polymethylene. S. Krimm. Letter in *J. Appl. Phys.*, **23**, 287 (*Feb.*, 1952).

It is stated that Brown's analysis [Abstr. 5693 (1949)] of the orientation of crystallites, when the polymer is stretched to elongations of 200%, is not consistent with an angle between the stretching direction and the long chain axis of the crystallite of 64°, but of 26°. A. J. TAYLOR

539.217

3904. The effect of physical factors on the passage of aqueous solutions across an oil barrier. W. Kopaczewski. *C.R. Acad. Sci.* [*Paris*] **234**, 210–12 (*Jan.* 7, 1952) *In French.*

A further comment on an earlier paper [Abstr. 811 (1952)] and a reply to Devaux [Abstr. 2154 (1952)]. Devaux's experiments were on writing paper, which is a complex system compared with the pure cellulose fibre filter paper used by the author. The effects of temperature, humidity, age (of oils, paper and solutions), viscosity of solutions, interfacial tension, micelle hydration and electric charge of ions in the solutions, on the penetration of oiled paper by coloured solutes have been investigated. All these factors modify the penetration. J. IBALL

539.217 : 541.183

3905. Kinetics of a fixed bed system for solid diffusion into spherical particles. J. B. Rosen. *J. Chem. Phys.*, **20**, 387–94 (*March*, 1952).

A solution is presented to the general problem of the transient behaviour of a linear fixed bed system where the rate of adsorption is determined by the combined effect of a liquid film and solid diffusion into spherical particles. The result obtained is an expression for the effluent following a sudden change in the influent concentration. It is given in two forms: (*a*) An exact solution to the problem in the form of an infinite integral suitable for numerical integration. (*b*) An approximation to the exact solution together with an expression for the leading error term in this approximation. The approximate solution and the

or term are given as closed trigonometric expressions which can be easily evaluated. A.

539.217

3906. The porosity of some adsorbents. A. IRÉTIEN AND D. PAPÉE. *C.R. Acad. Sci.* [*Paris*] **234,** 4–16 (*Jan.* 7, 1952) *In French.*

The amount of vapour taken up at p_0 (= saturated vapour press.) gives the volume of the micropores (I). The rate of adsorption at 20°C increases as p_0 increases. The total pore volume (II) is measured by immersing in a liquid (e.g. water), drying superficially and weighing. For boehmite and bayerite I is increased by calcining at 400°, whereas II is scarcely affected. For silica gel calcined at 800°, I increases towards its value for 400° when subjected to three alternate sorptions and desorptions. S. J. GREGG

539.217 : 539.172.4

3907. The effect of neutron irradiation on metallic diffusion. T. H. BLEWITT AND R. R. COLTMAN. Letter in *Phys. Rev.*, **85,** 384 (*Jan.* 15, 1952).

The electrical resistance of disordered Cu_3Au held at 200°C and irradiated by a flux of 10^{12} neutrons/sec in a pile, decreases exponentially with time, approaching closely a limiting value after *c.* 600 hr. A lag in the fall of resistance following a shut-down of the pile showed the relaxation time for ordering to have been reduced by the *n*-irradiation from 10^5 to 12 hr.
A. D. LE CLAIRE

539.217 : 539.231

3908. Cathodic sputtering for micro-diffusion studies. F. F. FISHER AND C. E. WEBER. *J. Appl. Phys.*, **23,** 81–3 (*Feb.*, 1952).

A method which has been developed to allow uniform removal of micro-layers of metal from cylindrical specimens is based on sputtering of the metal from the cathode of a gas glow discharge tube. This technique is directly applicable to diffusion studies and offers many advantages over other more common methods. A.

539.26

3909. The evaluation of back-reflection photographs for X-ray strain measurements. R. GLOCKER. *Z. angew. Phys.*, **3,** 212–16 (*No.* 6, 1951). *In German*

A discussion of approximations used and corrections required, in the method in which Debye–Scherrer rings from the strained metal are compared with those from a standard substance. A. R. STOKES

539.26 : 539.215.4

3910. Small angle X-ray scattering technique. K. L. YUDOWITCH. *Rev. Sci. Instrum.*, **23,** 83–90 (*Feb.*, 1952).

Theory is given for particle-size measurement by peak analysis and slope analysis of small-angle X-ray scattering. The basis for balance between intensity and resolution is discussed. Factors are weighed in considering the selection of camera geometry, suitable wavelength, method of monochromatization and recording of intensity distribution. A high-resolution small-angle scattering camera is described. Examples of its operation are given in particle-size determinations of Dow latex by peak analysis and colloidal gold by slope analysis. A.

539.27

3911. Electron microscope and diffraction studies of chromic oxides. R. TAKAGI. *J. Phys. Soc. Japan,* **6,** 350–1 (*Sept.–Oct.*, 1951).

The size, shape and crystallinity of chromic oxides prepared by various methods have been studied. The particles of chromic oxide obtained by the calcination of chromium trioxide at 400° ~ 1 300°C are of granular and irregular shape, while those obtained by the calcination of fluid mixture of chromium compound are plate-like, often exhibiting hexagonal shape, the flat surfaces of these crystals being parallel to (001). Higher calcination temperature up to 1 600°C merely increases the size of the particles, so that the distinction between the two types in shape remains as before. A.

539.27

3912. Shadow-casting with halides in the electron microscope. W. H. BARNES AND M. S. LAMBE. *Canad. J. Phys.*, **29,** 491–4 (*Nov.*, 1951).

Experiments on the behaviour of halides as shadow-casting agents in electron microscopy are described. The use of calcium fluoride, placed directly on the specimen screen, is suggested as a convenient method for routine qualitative shadowing of preparations in the preliminary stages of an electron microscopic study. No vacuum coating equipment is required. A.

539.27

3913. On the determination of the form and dimensions of particles of carbon black by electron microscopy. J.-B. DONNET AND J. BOISSIER. *C.R. Acad. Sci.* [*Paris*] **234,** 195–8 (*Jan.* 7, 1952) *In French.*

Particles of carbon black are found to be approximately spherical. In contrast to the results reported by other workers no sign of any increase in apparent particle size after a normal period of examination in the electron microscope is noticed, whether the particles are supported by a collodion film or one of Formvar. When supported by a film of Be, however, "contamination" is found to occur. J. THEWLIS

539.27

3914. A note on "Electron microradiography of electrodeposited metals." S. YAMAGUCHI. Letter in *J. Appl. Phys.*, **23,** 288–9 (*Feb.*, 1952).

See Abstr. 6672 (1951). Suggests that thin electrodeposited films of Ni on Cu and Zn used in a study on electroplating may be replicas of the Cu and Zn substrates. J. THEWLIS

539.27 : 542.936

3915. An electron diffraction study of the dehydration and decomposition of [certain] salts. R. LECUIR AND [MME] R. LECUIR. *C.R. Acad. Sci.* [*Paris*] **234,** 93–5 (*Jan.* 2, 1952) *In French.*

Diffraction patterns are given which show various stages in the *in vacuo* transformation of hydrated copper nitrate to cuprous oxide. The intermediate patterns are characterized by broad haloes of the compound $(NO_3)_2Cu \cdot 3Cu(OH)_2$. The transformation is contrasted with those of copper sulphate, nickel sulphate and copper chloride. R. S. PEASE

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31 : 530.162 : 535.55

3916. Statistical theory of rubber-like elasticity. V. The stress birefringence. A. ISIHARA, N. HASHITSUME AND M. TATIBANA. *J. Appl. Phys.*, **23**, 308–12 (*March*, 1952).

For Pt IV, see Abstr. 3027 (1952). The effects of network formation of non-Gaussian chains on the stress-birefringence are calculated. If the birefringence is plotted against the stress, the effects make the curve deviate from a straight line. When it is plotted against the elongation, the curve will rise above that corresponding to independent Gaussian chains in agreement with the experiments. A.

539.312

3917. The dynamic modulus of elasticity of regenerated cellulose fibres in relation to large deformation. H. DE VRIES. *Appl. Sci. Res.*, **A3**, 111–24 (*No.* 2, 1951).

The dynamic modulus of elasticity of regenerated cellulose fibres is traced in its dependence on the spinning stretch and the dry extension of a great number of samples. Two yield ranges in terms of extension of the fibre are distinguished. The structural changes involved are briefly discussed. A.

539.32

3918. Young's modulus and internal friction of polyvinylalcohol. N. TOKITA AND H. KAWAI. *J. Phys. Soc. Japan*, **6**, 367–71 (*Sept.–Oct.*, 1951).

Effect of temperature was investigated. E is almost constant at the room temperature, but it decreases rapidly beyond the characteristic temperature, which may be considered as the 2nd-order transition temperature, and it tends to the constant value at higher temperature. $\Delta W/2\pi W$ increases gradually from the room temperature and saturates to the constant value at higher temperature. Effect of humidity was also studied; E increases slightly up to R. H. 35% and beyond this point it decreases rapidly with increase of humidity; $\Delta W/2\pi W$ is almost constant up to 25% but it increases rapidly beyond this point and tends to the constant value at higher degree of humidity. Besides, effects of tension, degree of polymerization and frequency were reported shortly. The experimental formula which represents the temperature dependence of E was devised and this formula also was suitable to the experimental results of polyvinylchloride. The attempt to explain this formula from the statistical treatment of crystallite part and amorphous part was tried. A.

539.32

3919. The vibrational properties of wood. II. E. FUKADA. *J. Phys. Soc. Japan*, **6**, 417–21 (*Nov.–Dec.*, 1951).

For Pt I, see Abstr. 2090 (1951). When the moisture content is reduced from the air-dried state, the internal friction of wood increases and the peak in tan δ-frequency curve shifts to the lower frequency. The Young's modulus and tan δ decreases and peak of tan δ shifts to the higher frequency with the increase of temperature at the absolutely dried state. The experimental activation energy was found to be about 1 000 cal/mol. It is larger for the broad-leaved tree than for the needle-leaf tree. The frequency character of tan δ can be explained by superposing both Eyring's and Newton's viscosity. A.

539.32 : 548.57

3920. The elastic constants of ice single crystals. F. JONA AND P. SCHERRER. *Helv. Phys. Acta*, **25**, 35–54 (*No.* 1–2, 1952) *In German.*

Two effective methods for the growing of ice single crystals up to 9 cm in diameter and 6 cm in height are given. The five elastic constants of ice were determined from the optical diffraction patterns of crystals vibrating at high frequency [Schäfer–Bergmann method (1935)] for a temperature of −16°C. A comparison of the experimental with the theoretical values of Penny [Abstr. 2603 (1948)] shows satisfactory agreement. A.

539.32.096

3921. Thermal dependence of elastic constants of electrodeposited chromium. H. PURSEY. Letter in *Nature* [*Lond.*] **169**, 150 (*Jan.* 26, 1952).

Dynamic measurement of Young's modulus and rigidity modulus of an annealed specimen over a temperature range 10°–80°C. J. E. CAFFYN

539.373

3922. The theory of glide. F. VITOVEC AND H. NOWOTNY. *Z. Phys.*, **131**, 41–7 (*No.* 1, 1951) *In German.*

Becker's theory of glide is modified giving a critical shear stress τ_a/temperature T dependence of the form $\tau_a = \tau_0[1 - \kappa T]^{\frac{1}{2}}$ where κ is a constant depending on the glide velocity. J. E. CAFFYN

539.373

3923. Slip bands and hardening processes in aluminium. A. F. BROWN. *J. Inst. Met.*, **80**, 115–24 (*Nov.*, 1951).

Slip bands on Al increase in number during plastic deformation and, at the same time, further slip occurs within each band. At higher temperatures and lower rates of deformation, as well as with increasing strain under all conditions, the latter process becomes increasingly predominant. This is interpreted on the basis of the fine structure of slip bands which has been resolved by the electron microscope. The differences in density and inner structure of slip bands formed under different conditions are compared with the differences between stress/strain curves, and it is shown that slip which forms a new band involves much more macroscopic hardening than slip within an existing band. A consequence of this conclusion is that a mechanical equation of state can exist only at very small strains. A.

539.373

3924. A new surface structure in drawn aluminium. H. WILSDORF AND D. KUHLMANN-WILSDORF. *Naturwissenschaften*, **38**, 502 (*No.* 21, 1951) *In German.*

The stepped nature of the slip bands in drawn Al is confirmed by electron microscopy, a silica replica technique being used. Fine lines are also observed between the slip bands, which themselves have much smaller steps (10–20 Å). J. THEWLIS

539.373

5. Mosaic boundaries as energy thresholds for locations. A. SEEGER. *Naturwissenschaften*, **38**, –7 (*No.* 22, 1951) *In German.*

Expressions are given for the shear stress fields of dislocations at a grain boundary, and the potential rgy for a simple cubic crystal. The dislocation rgy thresholds are of the same order as the energy esholds of solution or formation. J. A. FRANKS

539.373 : 548.7

6. The production of large tensive stresses by locations. J. S. KOEHLER. Letter in *Phys. Rev.*, **85**, –1 (*Feb.* 1, 1952).

An array of n similar straight parallel edge dislocations each moving on the same glide plane and shed up against an obstacle by a uniform external aring stress t is shown to have large tensile stresses ociated with it, the maximum value being $\sim nt$. ch concentrations of tensile stress may be of imrtance in ductile fracture and fatigue.

A. D. LE CLAIRE

539.374

27. The extrusion of plastics. Z. RIGBI. Letter *Bull. Res. Coun. Israel*, **1**, 128 (*March*, 1951).

The ratio of the volume flow per sec for a plastic that of a Newtonian fluid may be $>$, $=$ or <1 pending on the geometry of the nozzle. J. E. CAFFYN

539.374

28. On the plastic deformation of zinc bicrystal. I. KAWADA. *J. Phys. Soc. Japan*, **6**, 362–6 (*Sept.*– *t.*, 1951).

The stress-strain curves of Zn specimens consisting two crystals have been studied in order to discuss e effect of grain boundaries. In each crystal of the crystal specimens the inclination of the base plane as fixed at 50° while the angle α between the plane of e grain boundary and the plane containing both the ecimen axis and the direction of maximum slope of e slip plane was varied as 0°, 45°, 90°, . . . 315°. The ecimen extended fairly well and the stress-strain rve varied systematically with the change of α in ch crystal. The shape of the cross-section of the ecimen changed sometimes into an elliptical form nd sometimes into a heart-shaped or wing-shaped rm according to the angle α. Moreover the speci- en twisted in some cases. A.

539.374

29. On the plastic deformation of copper single ystals. I. Two stages in the progress of deforma- on. H. KANZAKI. *J. Phys. Soc. Japan*, **6**, 454–5 *Nov.–Dec.*, 1951).

The stress-strain curves of Cu single crystals have en obtained at room temperature. When the solved shear strain reaches about 20%, the stress creases rather rapidly with increasing strain and thus e progress of deformation is found to be made up of o stages. This change in the nature of work- rdening may be explained from the view of the esence of two types of strains inside work-hardened etals that has been discussed in a previous paper bstr. 7326 (1951)]. If this view is correct, the mber of stopped dislocations is expected to show pid increase in the second stage of deformation. A.

539.374

3930. On the plastic deformation of copper single crystals. II. Recovery process and mean length of dislocations. H. KANZAKI. *J. Phys. Soc. Japan*, **6**, 456–9 (*Nov.–Dec.*, 1951).

The anomalous specific heat due to recovery from strain hardening has been measured on single crystals of Cu deformed at various temperatures. The apparatus for specific heat measurement is that of Nagasaki and Takagi. The maximum value of the energy stored during deformation at room temperature is found to be 0·1 cal/g. The energy released in the second valley of the specific heat anomaly (the energy accompanied with stopped dislocations) shows rapid increase when the resolved strain exceeds 25%. The recovery temperature takes the maximum value when the resolved strain is about 25%, and the crystals deformed at −180°C and −80°C recover sometimes below the room temperature. This may be explained by taking account of the length of dislocation lines. The density of dislocations is calculated from the dependency of recovery rate upon the degree of hardening. The value of the separation distance of dislocations obtained is about 200 Å and shows good agreement with the results obtained by electron microscope. A.

539.374

3931. Plasticity. M. VELASCO DE PANDO. *Rev. Cienc. Apl.*, **5**, 481–96 (*Nov.–Dec.*, 1951) *In Spanish.*

Contrary to the older theories of plasticity it is shown that the plastic transformations are not isovolumetric. Under the action of a plastifying tension, the crystals elongate in one direction in such a manner that a cylindrical anisotropy is produced. The relation between the tension and deformation follows the plastic diagram if they are parallel to the axis of the cylinder of anisotropy. In a direction perpendicular to the axis, the tensions and deformations follow the elastic diagram. The mathematical formulation of these theories is given and applied to a practical instance which is calculated numerically. W. SUMMER

539.374

3932. Distribution of activation energies for viscoelastic deformation. W. J. LYONS. Letter in *J. Appl. Phys.*, **23**, 287–8 (*Feb.*, 1952).

Using Maxwell's definition of relaxation time and reaction rate theory expressions for the rigidity modulus and the coefficient of viscosity, the relaxation time is expressed as a function of the activation energy per molecule. Hence, given the distribution function of the dynamic modulus $E(\tau)$, the distribution function for the activation energies follows.

J. E. CAFFYN

539.374

3933. Plastic deformation and the Meyer constants of metals. M. A. MEYER AND K. J. BLOK VAN LAER. Letter in *Nature* [*Lond.*] **169**, 237–8 (*Feb.* 9, 1952).

Experiments have shown that the Meyer indentation hardness relation, $H_m = H_0(a/r)^{n-2}$, where H_0 and n are constants, a the radius of the projected contact area, and r the indenter radius, and the stress-strain relation $\sigma = g\epsilon^x$, where g and x are constants of the metal, are each satisfied by Sn, Zn and Cd, and that

H_v increases and n diminishes with increasing cold-work. This does not accord with the work of Finniston, Jones and Madsden [*Nature* [*Lond.*] **164,** 1128 (*Dec.* 31, 1949)]. For any particular metal, cold-worked by an amount ε_0 and assuming no recovery, values of H_m plotted against $\varepsilon_0 + 0{\cdot}20a/r$ should lie on one curve for different a and ε_0 values. This is demonstrated. A. J. KENNEDY

539.374 : 533.6.011.4

3934. Application of the theory of supersonic flow to the two-dimensional isostatical problem in the theory of plasticity. N. INOUE. *J. Phys. Soc. Japan,* **6,** 460–5 (*Nov.–Dec.,* 1951).

Discusses the analogy between plastic flow and supersonic flow, by introducing a hypothetical fluid which has the special type of pressure-density relation $p/\log \rho$ = constant and the same local Mach number $\sqrt{2}$ throughout, and shows that the slip-lines, isostatics and boundary curves in the plastic flow correspond respectively to Mach lines, stream lines and shock waves in supersonic flow. By considering the stress plane similar to the hodograph plane for supersonic fluid flow, the non-linear problem of plastic flow is linearized and the new plastic state of stress is obtained by superposition of particular solutions. The case of simple waves is discussed in detail for plastic flow as well as for the flow of the hypothetical fluid here introduced. A.

539.38.096

3935. The effect of temperature on the anelastic properties of sodium chloride. J. CHATELET. *C.R. Acad. Sci.* [*Paris*] **234,** 347–9 (*Jan.* 14, 1952) *In French.*

A measurement by a dynamic method of the elastic modulus E and the internal friction δ of a single crystal of NaCl while slowly cycled through a temperature range 15 to 200°C at a rate of 0·1–0·2°C/minute. The curve of E plotted against T for one cycle is an open loop, suggesting the creation of internal tensions; these relax slowly on standing so as to close the loop and are considered to be associated with the observed changes in δ which has one maximum between 60 and 95°C and another near 200°C. The values of E during heating exceed those during cooling, where E varies linearly with T and $(1/E)dE/dT = -4{\cdot}43 \times 10^{-3}$; the differences are attributed to macroscopic thermal currents.

A. D. LE CLAIRE

539.389.3

3936. Effect of strain ageing upon the distribution of glide bands in cadmium crystals. D. F. GIBBONS. *Proc. Phys. Soc.* [*Lond.*] *B,* **65,** 193–5 (*March,* 1952).

It is shown that there is a marked difference in the distribution of visible glide bands, after plastic deformation, between Cd crystals containing small amounts of N and those relatively free from N. The distribution of glide bands in the crystals containing N is compared with Lüders bands in strain-aged mild steel. A.

539.4

3937. Resistance to the penetration of a bullet through an aluminium plate. J. NISHIWAKI. *J. Phys. Soc. Japan,* **6,** 374–8 (*Sept.–Oct.,* 1951).

539.4 : 539.216.1

3938. The elasticity and strength of paper and other fibrous materials. H. L. COX. *Brit. J. Appl. Phys.,* **3,** 72–9 (*March,* 1952).

An analysis is made of the effect of orientation of the fibres on the stiffness and strength of paper and other fibrous materials. It is shown that these effects may be represented completely by the first few coefficients of the distribution function for the fibres in respect of orientation, the first three Fourier coefficients for a planar matrix and the first fifteen spherical harmonics for a solid medium. For the planar case it is shown that all possible types of elastic behaviour may be represented by composition of four sets of parallel fibres in appropriate ratios. The means of transfer of load from fibre to fibre are considered and it is concluded that the effect of short fibres may be represented merely by use of a reduced value for their modulus of elasticity. The results of the analysis are applied to certain samples of resin-bonded fibrous-filled materials and moderately good agreement with experimental results is found. A.

539.4.011.25 : 666

3939. Breaking strength of glass. T. FUTAGAMI. *Mem. Fac. Engng Kyushu Univ.,* **12,** 245–61 (*No.* 3–4, 1951).

Measured for cylindrical rods under tension and for rectangular plates under tension and bending. Special attention is paid to (*a*) the dependence on size (the smaller the dimensions, the greater the strength), and (*b*) the effect of slits in the glass (the narrower the slit, the less the strength). Measurements are also made on Young's modulus and the rigidity modulus, both of which decrease as specimen size is reduced. An extrapolation suggests that Poisson's ratio tends to zero for fibres of order 10^{-5} cm thick. R. O. DAVIES

539.412 : 539.213

3940. On the strength of threads of amorphous material. G. BARTENEV. *Zh. Tekh. Fiz.,* **21,** 589–92 (*No.* 5, 1951) *In Russian.*

In her study [*Zh. Tekh. Fiz.,* **15,** 436 (1945)] of the tensile strength of threads produced from an amorphous substance by drawing, T. A. Kontorova did not take into account the fact that surface cracks have a greater effect than internal cracks. The author's derivation leads to the formula for the strength of thread, $P = \text{const.}/R\sqrt[4]{L} = \text{const.}/\sqrt[4]{L} = \sqrt{(v/v_0)}$, where R is the final radius and L the length of the thread, v_0 is the rate of flow of, e.g., molten glass, and v is the linear velocity of winding the thread on the drum. A. GELBTUCH

539.42 : 666

3941. The phenomenon of brittle fracture in silica glass. G. BARTENEV. *Zh. Tekh. Fiz.,* **21,** 579–88 (*No.* 5, 1951) *In Russian.*

The relation between the tensile strength of glass and the duration of fracture, derived from theoretical considerations, is found to coincide with the empirical formula of Holland and Turner for fractures of long duration. Brittle fracture of glass is determined by its max. strength and the coeff. of static fatigue. The latter was evaluated from bend tests designed to

idy the distribution of the duration of fracture with e applied load. A. GELBTUCH

539.434

42. Studies on the transient state of creep of etals. I. Creep of metals under bending or twisting oment. Y. SUEZAWA AND K. YAMAMOTO. *Bull. kyo Inst. Techn. B, No.* 2, 25–51 (1951).

A stress-strain-time relation is assumed; the creep a rectangular steel bar under a bending moment d of a steel wire under torsion is calculated. J. E. CAFFYN

539.434

043. Studies on the transient state of creep of etals. II. Creep of thick-walled cylinders under ternal fluid pressure. Y. SUEZAWA. *Bull. Tokyo st. Techn. B, No.* 2, 53–77 (1951).

The creep rate is calculated assuming a stress-rain-time relationship. J. E. CAFFYN

539.434

944. An investigation of the structural changes ccompanying creep in a tin–antimony alloy. W. ETTERIDGE AND A. W. FRANKLIN. *J. Inst. Met.*, **80,** 47–50 (*Nov.*, 1951).

A Sn–5% Sb alloy has been used for a micro-copical study of the phenomena occurring during reep at room temperature. In addition to general lip within the grains and flow at the grain boundaries, t is shown that localized strain within the grains ccurs in directions associated with the boundaries etween adjacent grains. This latter plastic flow will e important in any consideration of the quasi-iscous flow of grain boundaries, since it will influence he effective shearing force acting on the flowing oundary. It is also suggested from this work, and rom an examination of a pure Al sample strained in reep at 250°C, that the "cell structure" observed by -ray examination is a consequence of the break-up f the grains by the slip bands and by the local trains. A.

539.434

3945. Grain movements during creep. R. C. GIFKINS. Letter in *Nature* [*Lond.*] **169,** 238–9 (*Feb.* 9, 1952).

A Pb specimen containing 8 atoms % Th was extended by ~400% in ~200 days without re-crystallization or cracking being observed, and without appreciable preferred orientation. The most noticeable surface feature was the irregular and extended shape of a number of the larger grains. The general conclusion is that slow deformation occurs mainly by relative movements of the grains. A. J. KENNEDY

539.434 : 548.73

3946. X-ray diffraction investigations on creep in steel. W. EPPRECHT. *Schweiz. Arch. angew. Wiss. Tech.*, **18,** 10–21 (*Jan.*, 1952) *In German.*

The results of X-ray diffraction studies of a Ni–Cr alloy and two Ni–Cr steels during and after creep at elevated (570–750°c) temperatures. It is concluded that creep, involving principally slip in the austenite crystals, gives rise to hardening and also to the removal of the effects of previous cold-working. The relative importance of these two processes depends upon the magnitude of the applied stress. A. E. DE BARR

539.5

3947. Viscous solids subjected to distortions arbitrarily variable with time. G. RAINERI. *Atti Accad. Sci. Torino I,* **85,** 236–45 (1950–51) *In Italian.*

Theoretical. Analyses the effect of a time-variable distortion on an elastic and viscous solid, and considers the particular form of variation which does not produce an elastic effect. For the general case it is shown that the final deformation is independent of the manner in which the distortion varies with time. S. WEINTROUB

539.501

3948. The rheology of uterine cervical secretions. G. W. SCOTT BLAIR. *Appl. Sci. Res.*, **A3,** 89–101 (*No.* 2, 1951).

539.501

3949. A servo-controlled constant-stress rheometer. E. N. THROWER. *J. Sci. Instrum.*, **29,** 91–3 (*March*, 1952).

Constructional details are given for a constant-stress rheometer suitable for the investigation of the rheological properties of highly viscous materials. Cylindrical specimens, up to 2 in long, are compressed under either a constant load or a constant stress. For this compression a servo-system is employed which eliminates frictional errors, and makes possible the automatic recording of both deformation-time and recovery-time curves, without interfering with either process. The instrument is suitable for investigating a range of from 10^7 poises to 10^{12} poises. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.2

3950. Gas-liquid equilibria of mixtures of n-alkanes. G. W. NEDERBRAGT AND J. J. DE JONG. *Appl. Sci. Res.*, **A3,** 125–43 (*No.* 2, 1951).

The compositions have been determined of gas and liquid phase of hydrocarbon mixtures heated to temperatures near 300°c under pressures of 10 to 60 bars. In each case the mixtures were made up of two normal alkanes, one being pentane or heptane, the other having between 16 and 24 C atoms. The calculation method of gas-liquid equilibria of alkanes [Abstr. 5036 (1949)] was found to predict gas and liquid compositions in agreement with the measured values. A.

541.123.21

3951. The least drop of liquor as the borderline magnitude between the van't Hoff-equilibrium systems and the liquor-free syntheses of ocean salts. J. LEONHARDT. *Naturwissenschaften*, **38**, 477–8 (*No.* 20, 1951) *In German.*

The idea of the least liquor-drop (containing just as many H_2O molecules as are necessary to keep one molecule of solute in solution) is developed. If the number of H_2O molecules is still less, the liquor-free region is reached where, it is claimed, not all of the phase-rule implications are valid. F. LACHMAN

541.124

3952. Intramolecular isotope effects in the decarboxylation of malonic acid. P. E. YANKWICH, E. C. STIVERS AND R. F. NYSTROM. Letter in *J. Chem. Phys.*, **20**, 344 (*Feb.*, 1952).

The ratio of rate of rupture of C^{12}–C^{12} bonds to C^{12}–C^{x} ($x = 13$, 14) shows agreement with earlier results for C^{13}; for C^{14}, values differ from those of other authors. J. JACOBS

541.124

3953. Lifetimes of active molecules. I. R. A. MARCUS. *J. Chem. Phys.*, **20**, 352–4 (*March*, 1952).

The specific dissociation constants for various vibrationally excited molecules (methane, ethane and propane) are inferred from an interpretation of experimental data on atomic cracking reactions and on the deuterization of free radicals. As was to be expected, these dissociation constants decrease with increasing number of degrees of freedom of the decomposing molecule. A.

541.124

3954. Lifetimes of active molecules. II. R. A. MARCUS. *J. Chem. Phys.*, **18**, 355–9 (*March*, 1952).

Experimental data on the atomic cracking of propyl radicals and on the deuterization of methyl radicals are compared with some theoretical calculations. With the aid of some assumptions concerning intramolecular energy transfer in the dissociating molecules involved in these and other reactions and concerning the corresponding activated complexes, data on a number of free radical reactions are correlated. A.

541.124

3955. Recombination of methyl radicals and atomic cracking of ethyl radicals. R. A. MARCUS. *J. Chem. Phys.*, **20**, 364–8 (*March*, 1952).

The characteristics of this atomic cracking reaction and of the pressure and steric effects associated with the recombination of methyl radicals are all intimately related. The available data on these reactions are correlated by means of a previously developed theory. Some experimental results on the steric factor and the data on the remaining subjects appear to be consistent with the assumption that the methyl radicals must be highly oriented with respect to each other in order that recombination occur. However, experimental steric factors of unity have also been reported in the literature. The corresponding assumption of no orientation leads to disagreement with the remaining data unless some of the rotational degrees of freedom of the "active" molecule, in addition to the vibrations, are assumed to be "active." Even then, the difficulties are not completely removed. Further experimental work on these reactions is needed. A.

541.124

3956. Unimolecular dissociations and free radical recombination reactions. R. A. MARCUS. *J. Chem. Phys.*, **20**, 359–64 (*March*, 1952).

The steric and pressure effects associated with the recombination of free radicals both depend on the nature of the activated complex, and are therefore intimately related. From a consideration of the reverse process of unimolecular dissociation, some equations are derived for these properties using an extension of earlier transition state and quasi-unimolecular theories. The present formalism differs from previous formulations of the latter in a number of ways, particularly in the expression used for the density of quantum states of the high energy molecules. Subsequent applications of the theory tentatively suggest that essentially all vibrational degrees of freedom of these molecules can contribute their energy to the vibrationally excited molecules. Consequently, vibrational anharmonicity would appear to be an important factor in intramolecular energy transfer. The present paper is an extension of a previously developed theory for the recombination of methyl radicals and iodine atoms. A.

541.126

3957. The explosive reaction of carbon monoxide and oxygen at the second explosion limit in quartz vessels. A. S. GORDON. Letter in *J. Chem. Phys.*, **20**, 340–1 (*Feb.*, 1952).

A study of this reaction in a static system using both dried gases and an addition of water vapour has revealed that (1) there is a pronounced effect of both the surface and the presence of water on this reaction, (2) the addition of some gases (CO_2, N) lowers the explosion temperature, (3) no explosion could be observed when the pressure was reduced below the second explosion limit (about 250 mm at *c.* 700°C for the compositions investigated). F. LACHMAN

541.126 : 536.46

3958. Role of hydrogen atoms in flames: an expansion phenomenon. J. R. ARTHUR AND R. F. LITTLEJOHN. Letter in *Nature* [*Lond.*] **169**, 288–9 (*Feb.* 16, 1952). See also Abstr. 9064 (1950).

541.127

3959. A thermal method of following fast reactions in solution. R. P. BELL AND J. C. CLUNIE. *Proc. Roy. Soc. A*, **212**, 16–32 (*April* 8, 1952).

A method is suggested for measuring the velocity constants of rapid reactions in solution by observing the maximum or minimum temperature reached when the reaction takes place under non-adiabatic conditions. Theoretical expressions are derived relating the temperature change to the thermal constants of the system and to the velocity constants of reactions of zero, first and second order. A simple apparatus is described for applying this method, the temperature changes involved being less than 0·1°C, so that the variation of reaction velocity with temperature can be neglected. In order to test the method, experimental data are given at 0 and 25°C for the following

ctions of the first and second order: the alkaline drolysis of methyl acetate and of ethyl glycollate, acid-catalysed hydrolysis of diethyl acetal, and the ction of nitroethane with hydroxyl ions. There are systematic deviations from the theoretical relations. e internal consistency of the results and their agree- nt with other data show that velocity constants can measured with an accuracy of 2 to 3% for reactions th half-times in the range 3 sec to 3 min. A.

541.128

60. Hydrogen redistribution during olefine hydro- nation. C. D. WAGNER, J. N. WILSON, J. W. VOS AND D. P. STEVENSON. Letter in *J. Chem. ys.*, **20**, 338–9 (*Feb.*, 1952).

In the metal-catalysed reaction between olefine and uterium the product contains some deuterated raffin species with more than two D atoms per olecule; this indicates a type of exchange involving gration of H atoms among adsorbed hydrocarbon sidues. Olefine hydrogenation appears to be more mplex than hitherto believed. S. J. GREGG

541.128

61. The reversible dissociation of hydrogen mole- les and the *para*-hydrogen conversion. A. COUPER D D. D. ELEY. *Proc. Roy. Soc. A*, **211**, 536–43 *Aarch* 20, 1952).

An examination has been made of the hypothesis at the rate of the *para*-hydrogen conversion on W determined by the rate of condensation of hydrogen olecules into an almost full monolayer of chemi- rbed atoms. Using the Peierls equation, and ploying parameters consistent with the adsorption otherm and heat data (in particular an interatomic pulsion energy of $NV = 4\,800$ cal/mole), it is shown at the calculated values of absolute rate, activation ergy and pressure dependency are in disagreement th those observed experimentally. A.

541.128

62. The activation energy of the *para*-hydrogen nversion on tungsten. A. COUPER AND D. D. LEY. *Proc. Roy. Soc. A*, **211**, 544–63 (*March* 20, 52).

A study has been made of the activation energy, E, d frequency factor, B^0, for the conversion of *para*- rdrogen on W. All experiments were made at ound 1 mm pressure. The E and B^0 values are dependent of variations in wire length, bath tem- rature and wall thickness, factors likely to change e temperature distribution along the wire. The lues vary somewhat from one wire to another, and ay be more markedly modified by exposure to H oms or Na vapour. The values of E and $\log B^0$ fit linear relation, the physical reality of which is sup- rted by two facts: (*a*) a quite different slope is tained if the tungsten wire is "poisoned" with CO d other gases, (*b*) a relation of a different kind is und for Pd–Au alloy wires. It is tentatively sug- sted that the slope of the relation E *v.* $\log B^0$ is termined by the resonance interaction in the sorbed film, including the sites neighbouring the e on which the activated complex is formed. A.

541.128 : 541.183

63. The reaction between carbon monoxide and ygen on cuprous oxide at room temperature. W. E. GARNER, F. S. STONE AND P. F. TILEY. *Proc. Roy. Soc. A*, **211**, 472–89 (*March* 20, 1952).

The catalytic reaction has been studied on a granular surface of the metal coated with cuprous oxide. The nature of the adsorbed species in the stationary state of the reaction has been investigated by measurements of heats of adsorption and by B.E.T. measurements. The adsorption characteristics of cuprous oxide have been compared with those of cupric oxide, and some measurements have been made of the heats of adsorption of hydrogen, ethylene and sulphur dioxide on cuprous oxide. The differential heat of adsorption of oxygen during the formation of the first few layers of cuprous oxide on copper metal has been determined. A constant value of 55 kcal is obtained after the first few layers have been built up. The adsorbed oxygen reacts with carbon monoxide and dioxide, giving a CO_3 complex as an intermediate stage in the reactions. The properties of this complex have been studied by calorimetric methods and it has been shown to be unstable in the presence of carbon monoxide. The reactivity of the adsorbed oxygen decreases with time, and it is concluded that this is due to the diffusion of Cu^+ ions to the surface, which partially builds the oxygen ions into the lattice. The steps in the reaction mechanism of the catalytic reaction have been formulated, and it is shown that in the stationary state carbon monoxide, oxygen ions and a CO_3 complex are present on the surface, the last two species being present in small amount. An explanation is given of the dependence of the reaction on the oxygen pressure. A.

541.128 : 542.943

3964. Ferroelectric transitions and heterogeneous catalysis. G. PARRAVANO. Letter in *J. Chem. Phys.*, **20**, 342–3 (*Feb.*, 1952).

The rate of catalytic oxidation of CO by O_2 on the ferroelectrics $NaNbO_3$, $KNbO_3$ and $LaFeO_3$ shows a sharp maximum in the neighbourhood of the ferro- electric transition of the catalyst. This supports an electronic mechanism for the oxidation. S. J. GREGG

ELECTROCHEMISTRY 541.13

541.133

3965. The presumed ion $(H_3O)^+$. E. DARMOIS. *Bull. Soc. Chim. France*, **18**, 609–12 (*Sept.–Oct.*, 1951) *In French.*

It is stated on the basis of calculations of mobility and mean free path that in acid solutions the protons do not form $(H_3O)^+$ ions, but are surrounded by several water molecules, e.g. tetrahedrally.

A. J. TAYLOR

541.134.3

3966. Potentials of liquid-liquid contacts, illustrated by some solutions of copper salts at different tempera- tures. M. BONNEMAY AND J. FAIRBANK. *J. Rech. Cent. Nat. Rech. Sci., No.* 17, 66–8 (1951) *In French.*

Thermodynamic expressions are derived for the potential between copper salt solutions of different temperatures for the general case and for the case of pure solutions. Agreement with experimental results

is satisfactory for the latter case; the former is too complicated to be verified experimentally. A. J. TAYLOR

541.135

3967. Theory of strong electrolytes. M. EIGEN AND E. WICKE. Note in *Naturwissenschaften*, **38**, 453–4 (*No.* 19, 1951) *In German.*

This theory is developed on the assumption that ions and their hydrate shells when assigned characteristic volumes [cf. Abstr. 7559 (1950)] in the electrolyte solutions, afford the necessary distribution functions for the calculation of activity coefficients. Comparative curves are shown for results with univalent electrolytes and those calculated on the Debye–Hückel theory. Excellent agreement with experiment is found for HCl and LiCl. H. H. HODGSON

541.135

3968. Real solutions of polyelectrolytes. A. KATCHALSKY, H. EISENBERG AND S. LIFSON. Letter in *Bull. Res. Coun. Israel*, **1**, 116–19 (*Aug.*, 1951).

A thermodynamic relation is derived by which it is possible to calculate the electrostatic field energy of polyelectrolytes from experimental measurements (potentiometric titrations). These are carried out for polymethacrylic acid samples of various molecular weights. Results are compared with those obtained by the application of a theoretically derived approximate formula. The agreement is satisfactory. The necessary mean end-to-end distances of the molecules are obtained by viscosimetric measurements.

A. J. TAYLOR

541.135

3969. Electrolysis across semi-permeable membranes of copper ferrocyanide. A. BENZIMRA AND L.-H. COLLET. *C.R. Acad. Sci.* [*Paris*] **234**, 434–5 (*Jan.* 21, 1952) *In French.*

Electrolysis experiments through semi-permeable membranes of copper ferrocyanide with solutions of HCl, H_2SO_4, NaCl, KCl and $CuCl_2$, over a wide range of concentration, have not established any special effect due to the membrane. It is remarkable, however, that the membrane offers considerably less resistance to the passage of K than of Na ions.

H. H. HODGSON

541.135.5

3970. Study of electrolytic phenomena by means of weak alternating currents of variable frequency. I. EPELBOIN. *C.R. Acad. Sci.* [*Paris*], **234**, 950–2 (*Feb.* 25, 1952) *In French.*

Electrode phenomena are investigated for a Ni anode by superposition of a weak constant alternating current on the continuous polarization current, the impedance variation being a function of the frequency. A resonance effect is revealed which is related to the appearance of a diffusion layer at the electrode susceptible to selective dissolution. The electrolyte had the composition $HClO_4$, $6CH_3COOH$. H. H. HODGSON

541.135.5

3971. Electrolytic-slide-polishing. K. NAGAI AND K. MANO. *Sci. Rep. Res. Inst. Tôhoku Univ. B*, **1–2**, 391–8 (*March*, 1951).

In electrolytic slide polishing, the anode, which is made the metallic object to be polished, is not immersed in the electrolyte but is glided along the surface of a textile or glass wool (approximately 0·5–2·0 mm thick) soaked with the electrolyte, and beneath which is the cathode. An acid electrolyte, e.g. H_3PO_4 or sometimes a mixture of H_3PO_4 and H_2SO_4, is used for Cu, Al, Mn, Ni, Fe, Mo and their alloys, while a basic electrolyte, e.g. > 10% aqueous NaOH, is required for Al, Mn, W, and aqueous KCN or NaCu for Ag, Au and Pb. The method requires a larger voltage and c.d. than the conventional electrolytic processes, and its mechanism is explained together with a comparison of data with results obtained by the usual procedures.

H. H. HODGSON

541.135.5

3972. On an electrode of iodine trichloride in solution in ethyl oxide. M. LAUTOUT. *C.R. Acad. Sci.* [*Paris*] **234**, 330–2 (*Jan.* 14, 1952) *In French.*

541.135.5 : 539.211

3973. On the thinning of metallic strips by electrolytic polishing. C. CHALIN AND I. EPELBOIN. Letter in *J. Phys. Radium*, **12**, 885 (*Nov.*, 1951) *In French.*

Careful attention to anode support design leads to a uniform anode current density and consequently a uniform thinning. The physical properties of such thinned specimens are the true bulk properties of the material and differ from those of rolled specimens, the more so the thinner the specimens, on account of an "altered layer" introduced by rolling but removed by polishing. A. D. LE CLAIRE

541.135.5 : 539.211

3974. On the thinning of wires by electrolytic polishing. I. EPELBOIN AND A. P. GHAHERI. Letter in *J. Phys. Radium*, **12**, 885–6 (*Nov.*, 1951) *In French.*

The methods of the previous abstract are not practicable for wires, but their uniform thinning can be achieved by maintaining a uniform conc. gradient of the anodic solution products along the length of the wire: means of so doing are described. A. D. LE CLAIRE

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

3975. Photochemical behaviour of alkali halide crystals. W. MARTIENSSEN. *Naturwissenschaften*, **38**, 482–3 (*No.* 20, 1951) *In German.*

It has been found that KCl and RbCl crystals exhibit the same behaviour as KBr crystals when sensitized photochemically by the insertion into the crystal lattice of minute quantities of alkali hydrides.

F. LACHMAN

541.14

3976. Electronic recapture in fused quartz. A. SATOR. *C.R. Acad. Sci.* [*Paris*] **234**, 328–30 (*Jan.* 14, 1952) *In French.*

541.14

3977. A new approach to photosynthesis in vitro. N. URI. Letter in *J. Chem. Phys.*, **20**, 348 (*Feb.*, 1952).

A method of carrying out artificial photosyntheses is described. The systems considered are not identical with those in live cells, but they might be similar.

A. J. TAYLOR

541.15

978. Effects of electronic irradiation on fats. S. HANNAN AND J. W. BOAG. Letter in *Nature [Lond.]* **169**, 152–3 (*Jan.* 26, 1952).

541.15

979. Primary radiation yield in liquid water. S. DAINTON AND J. ROWBOTTOM. Letter in *Nature [Lond.]* **169**, 370–1 (*March* 1, 1952).

The radiation yield of the radiolysis of purified H_2O_2 in aqueous solution has been compared with the quantum yield of the photolysis of the same solution, under rigorously "clean" conditions. The rate of photolysis was found to be first order with respect to H_2O_2 concentration (range 1–22M); it was proportional to the square of the intensity of the light absorbed, and increased with temperature. Radiolysis rate was proportional to the square root of dose rate (range 4–160 r/min), and had the same temperature coefficient as the photolysis. In both reactions, the main-carriers are destroyed in pairs, and the propagation steps are bimolecular reactions between a main carrier and an H_2O_2 molecule. Mechanisms are discussed. The results lead, in the radiolysis, to a value of $13{\cdot}4 \pm 2{\cdot}2$ for the number of water molecules decomposed per 100 eV energy absorbed, as compared with 12·3 found by Haissinsky and Lefort and 3·3 by Hart. C. B. ALLSOPP

DISPERSIONS . COLLOIDS . ADSORPTION 541.18

541.183

980. Adsorption of potassium on tungsten. F. KNAUER AND W. KÜHL. Note in *Naturwissenschaften*, **38**, 432 (*No.* 18, 1951) *In German.*

A beam of K atoms interrupted *c.* 25 times per sec falls on a hot W wire (temp. $= T°$) and the ionization current, I, is measured. From the variation of I with T and with surface covering θ of the wire, it is concluded that the condition of the film, for a given θ, differs according as θ is increasing or decreasing. An explanation is proposed. S. J. GREGG

541.183

981. Study of oxygen adsorption on carbon by the thermoelectronic emission from the latter. X. DUVAL. *C.R. Acad. Sci.* [*Paris*] **234**, 208–10 (*Jan.* 7, 1952) *In French.*

It has been found that O introduced at pressures of 5×10^{-5}–5×10^{-4} mm Hg into an evacuated tube containing a carbon filament heated to 1 150–2 000°K has no detectable effect on the emission constant. Hence no O film is formed on C in these conditions. Other experiments have shown that the C filament had not been contaminated by adsorbed gases before the admission of O. F. LACHMAN

541.183

982. Relationship between the adsorption rate and the isotherm. D. PAPÉE. *C.R. Acad. Sci.* [*Paris*] **234**, 437–9 (*Jan.* 21, 1952) *In French.*

The adsorption of water vapour by various specimens of alumina and silica has been investigated, using either a current of N or static air, containing a certain proportion of H_2O. The shape of the adsorption/time curve is practically independent of the size of adsorbent (grains, tablets) in the case of static measurements, and curves obtained by static and dynamic methods are almost identical if the abscissae are properly altered. Each adsorbent has a characteristic adsorption curve whose shape depends upon the temperature of calcination. The comparison of the isotherm portions in the regions of the partial pressures studied with the corresponding adsorption/time curves reveals some elements of analogy and throws some light on the specific area and texture of the adsorbing surface. F. LACHMAN

541.183

983. Nonstoichiometric chemisorption of hydrogen on tungsten and nickel. J. C. P. MIGNOLET. Letter in *J. Chem. Phys.*, **20**, 341–2 (*Feb.*, 1952).

Measurements of contact potential by a (*a*) vibrating condenser, (*b*) thermionic, method show the formation of a positive, volatile, film (I) following that of the normal negative one. I may be due to an atomic adsorption which occurs in a film (II) having all the sites already occupied, thereby causing distortion of II. Details of (*b*) are given. S. J. GREGG

541.183

984. The adsorption of gases on metal filaments, films, and single crystals. A. D. CROWELL. *Amer. J. Phys.*, **20**, 89–98 (*Feb.*, 1952).

Particular stress is placed on the problem of uniform surfaces. An historical study follows which is specifically concerned with (1) metal filaments and evaporated films, and (2) surfaces of metal single crystals, both considered as approximations to ideal surfaces for adsorption measurements. A.

541.183 : 536.71

Van der Waals adsorption. *See Abstr.* 3557

541.183 : 541.128

The reaction between carbon monoxide and oxygen on cuprous oxide at room temperature. *See Abstr.* 3963

CHEMICAL STRUCTURE 541.2/.6

541.51

985. Electron distribution in conjugated free radicals. J. JACOBS. *J. Chem. Soc.* (1952) 292–8 (*Feb.*)

In the two systems $CH_{3-x}Ph_x$ and $CH_{3-x}(C_6H_4Ph)_x$ the free-valence numbers are deduced from an investigation of bond orders as defined in the molecular-orbital theory. The corresponding quantities arising in certain *p*-benzoquinone dimethides are also reported. On the basis of these data, changes in aromatic character of the hexagons under increasing phenylation are observed and the diradical behaviour of certain meriquinones is discussed. The results are correlated with predictions of reactivity ascribed to the presence of free electrons. A.

541.553

3986. Directed valency in elements of the first short period. J. W. LINNETT AND A. J. POË. *Trans Faraday Soc.*, **47**, 1033–41 (*Oct.*, 1951).

The electron configurations having maximum probability have been determined for atoms of elements in the First Short Period using determinantal wave functions which take account of the indistinguishability of electrons. The shapes of molecules and radicals derived from these atoms are considered in the light of the results. The valency directions in divalent beryllium, trivalent boron, in methane, ammonia and water, and in the methyl and methylene radicals have been considered. On the basis of the method presented, the inter-bond angles in NH_3 and H_2O would be expected to be slightly less than the tetrahedral, the angle in H_2O being more different from the tetrahedral than that in NH_3. A.

541.553 : 548.737

3987. The valence angle of the sulphur atom in diphenylsulphone. C. KEIL AND K. PLIETH. *Naturwissenschaften*, **38**, 546–7 (*No.* 23, 1951) *In German.*

A crystallographic investigation of 4–4′ di-iodo-diphenylsulphone. A. J. TAYLOR

541.57

3988. Conjugation of a hetero-atom across a single bond. C. A. COULSON AND J. DE HEER. *J. Chem. Soc.* (1952) 483–9 (*Feb.*).

The molecular-orbital method is used to provide a general discussion of the way in which the conjugation of a hetero-atom (e.g. a halogen) with a conjugated or aromatic hydrocarbon residue (e.g. phenyl) depends on the electronegativity of the hetero-atom and the resonance integral between the hetero-atom and the carbon atom to which it is attached. This conjugation is shown to depend more strongly on the resonance integral than has often been supposed. The dependence is different according as we measure the extent of the conjugation in terms of delocalization energy, bond order, or charge migration. A.

541.65 : 535.347–15

3989. Infra-red dichroism and chain orientation in crystalline ribonuclease. A. ELLIOTT. *Proc. Roy. Soc. A*, **211**, 490–9 (*March* 20, 1952).

See Abstr. 3171–2, 5271, 7730 (1951). Dichroism has been observed in the infrared spectrum of a single crystal of ribonuclease. The dichroism suggests that the crystal contains folded polypeptide chains whose direction is mainly along or near that of the *c* axis, in agreement with conclusions arrived at by Carlisle and Scouloudi from consideration of the X-ray diffraction pattern. A band ascribed to the N–H vibration of the amide groups in the side chains has been found to be dichroic, and this appears to show that the plane of the NH_2 group in the side chain amides is oriented parallel to the *b* axis of the crystal. A.

541.67

3990. A study of the monomer, dimer, and trimer of cyanamide. J. PLOQUIN AND C. VERGNEAU-SOUVRAY. *C.R. Acad. Sci.* [*Paris*] **234**, 97–9 (*Jan.* 2, 1952) *In French.*

The magnetic susceptibilities of solid cyanamide, dicyandiamide and melamine and of cyanamide in solution in various solvents have been measured, a decrease in specific susceptibility on polymerization being encountered. W. R. ANGUS

541.67

3991. The magnetic susceptibility of hydrochloric acid solutions of the chlorides of divalent copper and nickel. J. A. DIXMIER. *C.R. Acad. Sci.* [*Paris*] **234**, 99–101 (*Jan.* 2, 1952) *In French.*

The magnetic susceptibilities of solutions of $CuCl_2$ and $NiCl_2$ in HCl have been measured and the molar susceptibilities (χ_M) of the salts at various concentrations calculated using the additivity law. The observed diminution in the χ_M of $CuCl_2$ with increasing acid concentration suggests the presence of $[CuCl_6]^{\equiv}$ complex ions in the solution. W. R. ANGUS

541.67

3992. Comparison between the magnetic behaviour of oxygen and that of nitrogen in organic chemistry. J. PLOQUIN. *C.R. Acad. Sci.* [*Paris*] **234**, 436–7 (*Jan.* 21, 1952) *In French.*

The values of the magnetic susceptibilities of oxygen and nitrogen atoms are dependent upon the way in which they are bound in the molecules. The magnetic behaviour of different oxygen compounds is similar to compounds containing NH. It is suggested that on the basis of magnetic measurements of such compounds conclusions with respect to the type of binding can be drawn. A. J. TAYLOR

541.67 : 548.523 : 538.222

3993. A method for the calculation of the direction of the axis of maximum magnetic susceptibility in a crystal of $CuSO_4 . 5H_2O$, according to data furnished by the method of oriented crystalline nuclei. J. BLANDIN. *C.R. Acad. Sci.* [*Paris*] **234**, 540–3 (*Jan.* 28, 1952) *In French.*

See also Abstr. 2220 (1952). The method can be used for triclinic crystals. It is described for $CuSO_4 . 5H_2O$. Only the axis of maximum susceptibility can be determined by this method, not the other axes of the magnetic ellipsoid. A. J. TAYLOR

LABORATORY APPARATUS 542.1/.7

542.6

3994. Unsteady-state separation performance of cascades. I. E. W. MONTROLL AND G. F. NEWELL. *J. Appl. Phys.*, **23**, 184–94 (*Feb.*, 1952).

Concerns the exact solution of the non-linear differential equations which describe the time-dependent behaviour of multistage cascade separating processes for separation of two very similar molecular species. The Rayleigh separation law is postulated for each stage. The main questions of interest in the non-stationary operation of cascades involve (*a*) their behaviour while the concentration of the required component is being built up to the desired value; (*b*) the behaviour of the cascade during the transition from one stationary mode of operation to another; and (*c*) the manner in which local concentration fluctuations are propagated through the cascade. Analytical expressions that are suitable for the dis-

ssion of all of these points in square cascades are rived. The cases of finite, half infinite and infinite scades are considered with and without product ithdrawal. The linearization of a class of non-near 2nd-order partial differential equations is iefly discussed. A.

CHEMICAL PROCESSES 542.9

542.943

995. Oxidation of metallic uranium. J. Loriers. *R. Acad. Sci.* [*Paris*] **234,** 91–3 (*Jan.* 2, 1952) *In rench.*

The mechanism of oxidation of U resembles that of e. The initial oxide film is homogeneous but it evelops cracks as its thickness increases, and the xidation (mass/time) curve changes from the para-olic to linear type. F. LACHMAN

CHEMICAL ANALYSIS 543/545

545.3

996. The effect of methylcelluloses of varying egrees of polymerization on polarographic reductions. . Holleck and H. J. Exner. *Z. Naturforsch.*, **6a,** 63–7 (*Dec.*, 1951) *In German.*

It has been found that an addition of methyl-ellulose to buffered 0·001M solutions of *p*-nitro-niline at *p*H 11·0 causes during a polarographic eduction a variation of the current/potential curves, hich depends upon the degree of polymerization of ethylcellulose. When working with solutions of the same concentration by weight of methylcellulose, the smaller polymers were more active than the more highly polymerized products. F. LACHMAN

545.372

3997. The dropping mercury electrode R. J. Newcombe. Letter in *Nature* [*Lond.*] **169,** 240 (*Feb.* 9, 1952).

The variation of p.d. with time between a newly formed drop and the surrounding electrolyte is investigated by means of a cathode-ray oscillograph. The results show that during the drop formation at the end of the jet there is a time interval during which no positive charge collects on the drop, and that this time interval decreases as the rate of dropping increases, e.g. with a drop formation of 2 sec no charge was detected for 0·014 sec, but for 0·2 sec the interval was 0·007 sec. This variation can be explained by diffusion of the Hg ions in solution towards the jet. H. H. HODGSON

545.8 : 548.19

Chemical identification by a physical method. *See Abstr.* 4000

545.822

3998. Metallurgical microspectroscopy using micro-drills. F. R. Bryan. Letter in *J. Opt. Soc. Amer.*, **41,** 1061 (*Dec.*, 1951).

In an improved technique for identifying metallic constituents a 10% solution of collodion in butyl acetate is allowed to flow over the chips obtained by microdrilling out the minute portion of metal to be analysed (e.g. a graphite nodule in a nodular steel; dia. 0·001 in), and the resulting suspension is attached to a graphite electrode with butyl acetate for spectrographic arc analysis (λ2300–4000) in standard apparatus. J. GRANT

CRYSTALLOGRAPHY 548

548.1

999. Physical properties of crystals: the direct nspection method. F. G. Fumi. *Acta Cryst.*, **5,** 4–8 (*Jan.*, 1952).

The independent non-zero components of physical roperties of crystals can be obtained by direct nspection in all crystal classes in which one can find Cartesian orthogonal co-ordinates that do not trans-orm into linear combinations of themselves under the ymmetry operations, i.e. in the groups S_2–$\bar{1}$; C_{1h}–m, C_2–2, C_{2h}–2/m; C_{2v}–2mm, D_2–222, D_{2h}–mmm; C_4–4, S_4–$\bar{4}$, C_{4h}–4/m, C_{4v}–4mm, D_{2d}–$\bar{4}$2m, D_4–42, D_{4h}–4mmm; C_3–3, S_6–$\bar{3}$, C_{3v}–3m; T–23, T_h–m3, T_d–$\bar{4}$3m, O–432, O_h–m3m. The method is applied to a general third-order tensor (polar or axial) in C_3, S_6, C_{3v}, T_d, O, O_h; to a fourth-order polar tensor r_{rs} (r, s = 1, 2, 3, 4, 5, 6) in C_4, S_4, C_{4h}, C_3, S_6, T, T_h correcting the erroneous results of Pockels on photo-lastic constants); and to a sixth-order polar tensor $t_{ikl} = t_{ilk}$ (i, k, l = 1, 2, 3, 4, 5, 6) in monoclinic and orthorhombic groups and in C_{4v}, D_{2d}, D_4, D_{4h}. A.

548.12 : 535.55

Photoelasticity and crystal symmetry. *See Abstr.* 3515

548.19 : 545.8

4000. Chemical identification by a physical method. M. W. Porter. *Endeavour* [*Lond.*] **10,** 188–93 (*Oct.*, 1951).

A brief account of the Barker Index of interfacial angles, with an outline of the historical development and some examples of its use in identification of crystal samples.

548.24

4001. Effect of a copper surface film on twinning in zinc mono-crystals. J. J. Gilman. Letter in *Nature* [*Lond.*] **169,** 149–50 (*Jan.* 26, 1952).

The critical tensile stress for twinning in zinc monocrystals is markedly increased when the surface of the crystal is covered with a thin film of electro-deposited copper. The effect seems to be caused by some sort of interaction between the copper and the zinc at the surface. A. E. De Barr

548.32

4002. Crystal morphology as a criterion for isomorphism. G. Kalb. Note in *Naturwissenschaften,* **38,** 560–1 (*No.* 24, 1951) *In German.*

Examination of natural crystalline overgrowths of bravoite (NiS_2)-iron pyrites confirmed the rule, that

two types of crystals of different form, produced under similar conditions, do not form mixed crystals.

J. A. FRANKS

548.5

4003. Snow crystals, natural and artificial. B. J. MASON. *Endeavour* [*Lond.*] **10,** 205–12 (*Oct.*, 1951).

548.5

4004. Oriented growth of camphor and camphor-like compounds. M. BRANDSTÄTTER. Note in *Naturwissenschaften*, **38,** 525 (*No.* 22, 1951) *In German.*

Camphor, borneol, isoborneol and bornyl chloride were grown on various phenols, nitro-compounds and amides. Microscopic examination showed that some degree of orientation always occurred, some substrates gave perfect orientations over large areas. The optimum sublimation temperature ranged between 45 and 60°C (camphor 50°C). J. A. FRANKS

548.5

4005. On anomalous mixed crystals in the range of fluorite type lattices. G. BRAUER AND H. GRADINGER. Note in *Naturwissenschaften*, **38,** 559–60 (*No.* 24, 1951) *In German.*

It is well known that mixed crystals are formed between fluorite type crystals and those of different structure. A study of the continuous change of lattice constant for mixtures of fluorite and sesquioxide crystals is made. CeO_2–Y_2O_3 form a continuous mixed crystal system, but in ThO_2–Y_2O_3, La_2O_3, Nd_2O_3, Sm_2O_3 or Gd_2O_3 and in CeO_2–Sm_2O_3 or Yb_2O_3 a limiting miscibility occurs with a definite relation to the lattice constants. G. F. J. GARLICK

548.5

4006. A method of preparation of monocrystals. H. PIATIER AND A. ACCARY. Letter in *J. Phys. Radium*, **12,** 886–7 (*Nov.*, 1951) *In French.*

Describes a device for preparation of large single crystals in an inert atmosphere. A. R. STOKES

548.5

4007. On the crystallization of thin Cu films. Experimental results. A. COLOMBANI AND G. RANC. *C.R. Acad. Sci.* [*Paris*] **234,** 78–80 (*Jan.* 2, 1952) *In French.*

The previous work [Abstr. 5901 (1951)] is extended to Cu. Ohm's law is not obeyed at small thicknesses t. The critical thickness c, at which the time variation of the resistivity is zero, is independent of the voltage at least up to 220 V/cm. On Plexiglas $c = 110$ Å, on NaCl $c = 65$ Å. The thickness at which the film obtains a crystalline structure is less for a crystalline than for an amorphous substrate. The electron microscope shows that there are many more micro-crystals on a crystalline than on an amorphous substrate. Their number and size grow with t: at $t = 90$ Å their mean size is 160 Å, but some are as large as 2 000 Å. Four figs. R. A. WEALE

548.528 : 536.423.4

4008. Reactions at crystal surfaces. I. N. STRANSKI. *Trans Chalmers Univ. Techn.* [*Gothenburg*] *No.* 114, 21 *pp.* (1951) *In German.*

A report of a lecture given at the Chalmers University of Technology, dealing with work carried out in the past few years at the Kaiser Wilhelm Institute of Physical Chemistry and Electrochemistry in Berlin-Dahlem. It is concerned with the work of E. W. Müller on the mobility of atoms on crystal surfaces, carried out with the aid of the field electron microscope; with work by Müller, Stranski and Honigmann on the equilibrium habit of crystals; with the investigations of Stranski and his collaborators on the condensation of crystals from the vapour phase; and with the work of Pollermann on the conditions governing the condensation of water droplets on ions in a Wilson cloud-chamber. J. THEWLIS

548.574

4009. Etching experiments on monocrystals in an electric field. W. KLEBER AND H. O. KOCH. Note in *Naturwissenschaften*, **39,** 19–20 (*No.* 1, 1952) *In German.*

Presents the results of an investigation on the effect of various electric fields (alternating, constant, pulsating) on the appearance of etching figures obtained on quartz monocrystals treated with 40% HF; similar figures were obtained on ZnS crystals. F. LACHMAN

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

4010. Dislocation structures in cubic face-centred crystals. I. G. LEIBFRIED AND H.-D. DIETZE. *Z. Phys.*, **131,** 113–29 (*No.* 1, 1951) *In German.*

This enlarges on Peierls's (1940) calculations. Dislocations of the (010) and (111) planes are calculated for several special cases. C. TURNER

548.7

4011. Dislocation structures in cubic face-centred crystals. II. H.-D. DIETZE. *Z. Phys.*, **131,** 156–69 (*No.* 2, 1952) *In German.*

Continuation of preceding abstract. The forces acting on the atoms in the lattice are no longer integrated, and the atoms are taken to have measurable dimensions. An "elastic limit" is calculated. The dislocation structures are not altered by this modification of Peierls's theory. C. TURNER

548.7

4012. The non-Hookean interaction of a dislocation with a lattice inhomogeneity. M. A. JASWON AND A. J. E. FOREMAN. *Phil. Mag.*, **43,** 201–20 (*Feb.*, 1952).

The equilibrium position of an edge dislocation near certain types of lattice irregularities is investigated quantitatively, using the Peierls's model of a dislocation. The external shear stress required to maintain equilibrium is calculated and the result extended to an array of like dislocations piled up against a barrier. The integral equation for the atomic displacements is linearized by a perturbation technique, the resulting equation being solved exactly. A.

548.7 : 535.372 : 535.43

Electron- and vibration-levels of the benzene molecule and crystal. *See Abstr.* 3455

548.7 : 535.375.54

The orientation of NH_4 ions in ammonium halide crystals. *See Abstr.* 3487

548.7 : 537.533 : 537.58

13. Wave-mechanical theory of crystal surfaces king account of metallic electrons. K. ARTMANN. *Phys.*, **131**, 244–65 (*No.* 2, 1952) *In German.*

A calculation of the surface states of electrons in ystals is followed by a discussion of surface emission d other properties. The potential used is not parable into three simply periodic potentials like at of Shockley [*Phys. Rev.*, **56**, 317 (1939)], but the sults obtained in both cases are consistent.

J. R. MADDOX

548.7 : 539.11

The significance of imperfections in crystal structure r the physics of solids. *See Abstr.* 3763

548.7 : 539.11

The stability of hexagonal lattices with a simple law f force. *See Abstr.* 3764

548.7 : 539.153.1

Ionic radii of iron-group elements. The influence of ystalline field. *See Abstr.* 3800

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See bstr.* 3909–15

548.732

4014. Asymmetric X-ray reflexions from abraded rystals. P. GAY, P. B. HIRSCH AND J. N. KELLAR. *cta Cryst.*, **5**, 7–11 (*Jan.*, 1952).

Intensities of X-ray reflection from abraded crystals ere measured as a function of asymmetry and urface treatment. The results have been explained n terms of surface imperfections, evidence for which as found by electron diffraction as well as by X-ray iffraction methods. The importance of the results n relation to the use of plane-crystal monochromators s discussed. It is also shown that, under certain onditions, integrated reflections can be measured rom stationary crystals. A.

548.732

4015. A non-undulatory deduction of the formulae or diffraction of particles by a crystal. F. J. WIŚNIEWSKI. Letter in *Nuovo Cim.*, **9**, 186–8 (*Feb.*, 952) *In French.*

Hamilton's principle of least action is used to btain the Laue conditions for diffraction of photons r other particles. An arbitrary constant occurs which s identified with Planck's constant. A. R. STOKES

548.734.3

4016. Theoretical study of the effect, when using a divergent beam, of absorption in the specimen and of experimental conditions on the homogeneity of Debye–Scherrer–Hull lines. C. STORA. *J. Phys. Radium*, **13**, 28–34 (*Jan.*, 1952) *In French.*

See Abstr. 3201, 4906 (1951). The conditions for the occurrence of a satellite line beside the main line are shown to depend on absorption coefficient and size of the specimen, angle of diffraction, width of entrance slit and camera diameter. A. R. STOKES

548.735.4

4017. Crystal-structure determination by means of a statistical distribution of interatomic vectors. H. HAUPTMAN AND J. KARLE. *Acta Cryst.*, **5**, 48–59 (*Jan.*, 1952).

The structure-factor equations are interpreted as coupled, closed-vector polygons. This interpretation permits the application of the random-walk problem to yield the probability distribution of the structure factors and of the co-ordinate differences between specified pairs of atomic centres in the case of rigid crystals. In practice the intensities must be corrected for vibrational motion. All crystals may be treated with the probability formula for the general asymmetric case, and the symmetry which exists in the crystal will automatically be obtained. Probability distributions which make use of an *a priori* knowledge of the crystal symmetry may also be obtained, and the case of the centrosymmetric crystal is worked out in detail. The relationship between the probability distribution for the interatomic vectors and the Patterson synthesis is derived. A.

548.736.1/.3

4018. Crystal chemical studies of the 5*f*-series of elements. XVI. Identification and crystal structure of protactinium metal and of protactinium monoxide. W. H. ZACHARIASEN. *Acta Cryst.*, **5**, 19–21 (*Jan.*, 1952).

548.736.3

4019. Crystal chemical studies of the 5*f*-series of elements. XV. The crystal structure of plutonium sesquicarbide. W. H. ZACHARIASEN. *Acta Cryst.*, **5**, 17–19 (*Jan.*, 1952).

For Pt XIV, see Abstr. 6589 (1951).

548.736.3

4020. Crystal structure of GeTe. K. SCHUBERT AND H. FRICKE. Letter in *Z. Naturforsch.*, **6a**, 781–2 (*Dec.*, 1951) *In German.*

At high temperatures GeTe has the NaCl structure with $a = 5{\cdot}98_0$ kX (390°C, Te-rich) to $5{\cdot}99_8$ kX (460°C, Ge-rich). Below the temperatures mentioned the symmetry decreases. The Ge-rich alloy assumes the As type with superstructure ($a = 5{\cdot}97_2$ kX, $\alpha = 88{\cdot}37°$ at room temperature); the complex structure of the Te-rich alloy has not been elucidated. The effect of electron concentration in determining alloy structures is discussed. A. J. C. WILSON

548.736.3

4021. Studies of the crystalline transformations of a single crystal of pyrolusite with increase of its catalytic and depolarizing properties. A. GRUND AND J. BRENET. *C.R. Acad. Sci.* [*Paris*] **234**, 345–7 (*Jan.* 14, 1952) *In French.*

Weissenberg photographs of an untreated crystal of pyrolusite from Kreutlich, Germany, showed a perfect rutile pattern with $c = 2{\cdot}86$ Å. On activation, the cryptomelane pattern appeared, with b oriented parallel to c of the original pattern but the other axes in random orientation. A powder ring ($d = 4$ Å) characteristic of γ MnO_2 also appeared, and streaks probably due to Mn_2O_3 with [110] parallel to c of the original pattern. A. J. C. WILSON

548.736.3

4022. The structure of tetragonal tungsten trioxide. W. L. KEHL, R. G. HAY AND D. WAHL. *J. Appl. Phys.*, **23**, 212–15 (*Feb.*, 1952).

A study of tungsten trioxide (WO_3) by differential thermal analysis and X-ray diffraction at temperatures up to 980°C showed a new tetragonal form to exist at temperatures of 740°C and higher. This form has a distorted ReO_3 structure. There are two molecules in a unit cell of dimensions $a_0 = 5{\cdot}25$ Å, $c_0 = 3{\cdot}91$ Å.

All atoms lie in the 2- or 4-fold special positions of the space group $P4/nmm$. The tungsten atoms are alternately displaced in opposite directions from the centre of charge of the oxygen atoms so as to resemble the antiferroelectric structure proposed by Kittel. A.

548.736.3 : 539.185

4023. The crystal structure of thorium and zirconium dihydrides by X-ray and neutron diffraction. R. E. Rundle, C. G. Shull and E. O. Wollan. *Acta Cryst.*, **5**, 22–5 (*Jan.*, 1952).

Thorium forms a tetragonal lower hydride of composition ThH_2. The hydrides ThH_2, ThD_2 and ZrD_2 have been studied by neutron diffraction in order that hydrogen positions could be determined. The hydrides are isomorphous, and have a deformed fluorite structure. Metal-hydrogen distances in thorium hydride are unusually large, as in UH_3. Thorium and zirconium scattering amplitudes and a revised scattering amplitude for deuterium are reported. A.

548.736.4

4024. Lithium metastannate. F. Hund and G. Lang. Note in *Naturwissenschaften*, **38**, 502–3 (*No.* 21, 1951) *In German.*

A note on the preparation and crystal structure of Li_2SnO_3. The crystals are hexagonal with $a = 9{\cdot}00$, $c = 14{\cdot}70$ and 18 molecules in the unit cell. They are uniaxial with similar optical behaviour to those of Na_2SnO_3. A. E. De Barr

548.736.5

4025. On the space group of kainite, $KCl \cdot MgSO_4 \cdot 3H_2O$. H. Linstedt. Note in *Naturwissenschaften*, **38**, 476 (*No.* 20, 1951) *In German.*

Monoclinic, $a = 19{\cdot}76$, $b = 16{\cdot}26$, $c = 9{\cdot}57$ Å, all $\pm$ ½‰, $\beta = 94°56'$, $Z = 16$. Absent reflections show only C-face centring; if the crystal class is $2/m$ the space group is $C2/m$. A. J. C. Wilson

548.736.5 : 537.226.2

4026. Structural changes in the ferroelectric transition of KH_2PO_4. B. C. Frazer and R. Pepinsky. Letter in *Phys. Rev.*, **85**, 479–80 (*Feb.* 1, 1952).

Relative displacements of the ions parallel to the c-axis were measured above and below the Curie point. For K these were appreciable, suggesting an unsuspected K-contribution to polarization. J. Jacobs

548.736.5 : 539.164.93

4027. On the order-disorder transition in the crystalline lattices of radioactive minerals. P. Pellas. *C.R. Acad. Sci.* [*Paris*] **234**, 538–40 (*Jan.* 28, 1952) *In French.*

The mean path of α-particles (the "effective density," μ) in allanite, fergusonite and thorite can be approximately calculated. The α-flux necessary for the transition has already been given for these minerals [Abstr. 2268 (1952)], and the % displaced atoms (n) is thus deduced. Two points are discussed: (1) the large difference in n for allanite and thorite for which the μ-values are almost equal, and (2) the question of high local temperatures being attained along the path of the recoil nucleus, a possibility proposed by Seitz [Abstr. 1893 (1950)] to explain order-disorder result in Cu_3Au. A. J. Kennedy

548.736.6

4028. The crystal structure of tricalcium silicate. J. W. Jeffery. *Acta Cryst.*, **5**, 26–35 (*Jan.*, 1952).

Three polymorphic forms of tricalcium silicate, $3CaO \cdot SiO_2$, the most important constituent of Portland cement clinker, have been studied. All three are strongly pseudo-rhombohedral, with hexagonal axes $a = 7{\cdot}0$, $c = 25{\cdot}0$ Å approximately. The pseudo-structure has been determined. The space group is $R3m$ and $Z = 9$ for the hexagonal cell. The true symmetry, cell size and space group have been determined for the form known as alite, which has a composition $54CaO \cdot 16SiO_2 \cdot Al_2O_3 \cdot MgO$. This form is monoclinic, Cm, with $a = 33{\cdot}08$, $b = 7{\cdot}07$, $c = 18{\cdot}56$ Å, $\beta = 94°\,10'$, and has two "molecules" per unit cell. Some preliminary deductions are made about the position of the Al and Mg atoms in the unit cell and also about the type of distortion of the pseudo-structure which would account for the diffraction effects. A.

548.737

4029. The crystal structure of the sydnones. I. G. M. J. Schmidt. Letter in *Bull. Res. Coun. Israel*, **1**, 121–2 (*March*, 1951).

Unit cells and space groups are given for six compounds containing the five-member ring $\overline{NNOCC}$.

A. J. C. Wilson

548.737

4030. Two examples of the use of the Fourier transform method in the analysis of crystal structures. F. H. Herbstein and G. M. J. Schmidt. Letter in *Bull. Res. Coun. Israel*, **1**, 123–4 (*March*, 1951).

The space group and unit cell of phenazine [Abstr. 309 (1941)] are confirmed to be $P2_1/a$, $a = 13{\cdot}22 \pm 1$, $b = 5{\cdot}061 \pm 5$, $c = 7{\cdot}088 \pm 7$ Å, $\beta = 109°13' \pm 7'$, $Z = 2$. Those for tetrabenznaphthalene are found to be $P2_1/a$, $a = 17{\cdot}81 \pm 2$, $b = 7{\cdot}74 \pm 2$, $c = 12{\cdot}18 \pm 1$, $\beta = 119°\,33' \pm 7'$, $Z = 4$. Approximate structures, of which no details are given, have been found for each by the Fourier-transform method.

A. J. C. Wilson

548.737

4031. Structure of the molecular compound $CaBr_2 \cdot 10H_2O \cdot 2(CH_2)_6N_4$. A. Addamiano and G. Giacomello. *Ric. Sci.*, **21**, 2121–31 (*Dec.*, 1951) *In Italian.*

Cubic, $Fm3m$, $a = 14{\cdot}34$ Å, density $1{\cdot}46$ g/cm³ (measured), $1{\cdot}49$ (calculated), $Z = 4$, Ca in (b), N in (f) with $x = 0{\cdot}191$, C in (g) with $x = 0{\cdot}133$, Br + O in $2\times(e)$ with $x = 0{\cdot}158$ and $0{\cdot}342$. The Ca ions are surrounded octahedrally by Br and H_2O. The structure determination was by Patterson and Fourier projections on the cube face; the reliability index is 20%. A. J. C. Wilson

548.737

4032. The unit-cell dimensions of potassium soaps. T. R. Lomer. *Acta Cryst.*, **5**, 11–14 (*Jan.*, 1952).

Powder photographs have been prepared for a series of potassium soaps at 25 and 75°C. Three distinct crystalline phases are recognized; their transition temperatures are given and the unit-cell dimensions are determined for each existing phase of all the soaps. A.

548.737

33. The application of Booth's method of steepest cents to the determination of the structure of assium caproate. T. R. LOMER. *Acta Cryst.*, **5**, -17 (*Jan.*, 1952).

The crystal structure of potassium caproate has n determined from powder photographs alone by application of the method of steepest descents. e use of the method is discussed, and the means of ercoming some of its limitations is indicated. A.

548.737

34. On the structure of indigo and its derivatives. VON ELLER. Note in *Acta Cryst.*, **5**, 142 (*Jan.*, 52) *In French.*

548.737

35. The crystal structure of formic acid. F. LTZBERG, B. POST AND I. FANKUCHEN. Letter in *Chem. Phys.*, **20**, 198 (*Jan.*, 1952).

Orthorhombic, *Pna*, $a = 10{\cdot}22$, $b = 3{\cdot}62$, $c = 34$ Å at $-45°$C, all $\pm 0{\cdot}03$ Å, $Z = 4$. No details structure; the formation of dimers is improbable.

A. J. C. WILSON

548.737

36. X-ray study of solid methanol. B. DREYFUS-AIN AND J.-M. DUNOYER. *C.R. Acad. Sci.* [*Paris*] **4**, 320–2 (*Jan.* 14, 1952) *In French.*

Debye–Scherrer patterns were obtained at a series temperatures between the melting-point of methanol d the boiling-point of liquid air. Between 159° d 175°K it is hexagonal, $a = 4{\cdot}44 \pm 4$, $c = 7{\cdot}25 \pm$ Å at 165°K. Below 159°K additional lines appear, d the pattern has not been interpreted.

A. J. C. WILSON

548.737

37. The lattice arrangement of crystalline methanol tween 159° and 175°K. B. DREYFUS-ALAIN AND . VIALLARD. *C.R. Acad. Sci.* [*Paris*] **234**, 536–8 *an.* 28, 1952) *In French.*

See also preceding abstract. The cell contains two olecules of probable symmetry *3m* [neglecting the of OH]. A possible arrangement of molecules d H bonds is suggested. A. J. C. WILSON

548.737

38. New type of X-ray evidence on the molecular ructure of globular proteins. D. P. RILEY AND . W. ARNDT. *Nature* [*Lond.*] **169**, 138–9 (*Jan.* 26, 52).

Scattering curves for bovine serum albumen, btained with a Geiger-counter spectrometer, were ed to give a radial distribution curve of electron ensity. Comparison with curves calculated for auling and Corey's helical structures [*Proc. Nat. cad. Sci.* [*Wash.*] **37**, 205–10 (*April*); 282–6 (*May*, 51)] clearly favours one of their α-helix structures ith 3·7 residues per turn rather than any of the her structures. A. R. STOKES

548.737

39. Structure of molecular compounds. X. rystal structure of the compound of benzene with an nmonia-nickel cyanide complex. J. H. RAYNER ND H. M. POWELL. *J. Chem. Soc.* (1952) 319–28 *Feb.*).

The compound $Ni(CN)_2,NH_3,C_6H_6$ has a tetra-onal unit cell, $a = 7{\cdot}24$, $c = 8{\cdot}28$ Å, which contains atoms corresponding to twice this formula. Co-valencies link Ni atoms through CN groups to form an extended flat network. Half the Ni atoms have four cyanide C atoms attached by square bonds. The metal-to-C distance indicates some double bonding between these atoms. The other nickel atoms are linked to four N atoms of CN groups in the form of a square, and to two NH_3 groups which complete an approximately regular octahedron of N atoms. The Ni–N distances correspond to single bonds. Layers of this structure are arranged parallel to each other and between them are benzene molecules with their planes at right angles to that of the layers. Each benzene molecule is comparatively remote from Ni atoms. It is contained in a cavity where it makes contacts at van der Waals distances with other benzene molecules and with atoms of cyanide and ammonia groups. It is not linked by chemical bonds to the nickel complex. Some observations on related compounds are recorded. A.

548.737

4040. Evidence for the Pauling–Corey α-helix in synthetic polypeptides. W. COCHRAN AND F. H. C. CRICK. Letter in *Nature* [*Lond.*] **169**, 234–5 (*Feb.* 9, 1952).

X-ray diffraction intensities obtained by Bamford and others agree well with the authors' theory of the general trend of intensities for a helical structure.

A. R. STOKES

548.737 : 541.553

Crystallographic study of 4–4′ di-iododiphenyl sulphone. *See Abstr.* 3987

548.74

4041. Accurate measurement of lattice constant by means of electron diffraction. Lattice constant of KCl referred to Au. N. KATO. *J. Phys. Soc. Japan*, **6**, 502–7 (*Nov.–Dec.*, 1951).

The experimental method adopted was the same as that of Finch and Wilman. The following effects which might cause errors in the measurement were either eliminated or proved to be of negligible order: inadequate setting of specimen of photographic plate to electron beam; refraction; charging up of the plate; temperature elevation by electron-impact. With beaten Au foil or evaporated Au film annealed at 300°C as the standard references, the following results were obtained on the lattice constant of KCl in both cases: with KCl films immediately after preparation by vacuum evaporation, it was $+0{\cdot}3 \sim 0{\cdot}15\%$ larger than the X-ray value; by exposure of the film to air, the deviation decreased to a stationary value of $+0{\cdot}15\%$; and a specimen prepared by precipitation from aqueous solution showed the above stationary deviation. A.

548.74

4042. Electron microscopy of metallic single crystals. S. YAMAGUCHI. Note in *Naturwissenschaften*, **39**, 19 (*No.* 1, 1952) *In German.*

Electron diffraction and electron microscope pictures of an etched single crystal of Permalloy are compared. The two methods are complementary and throw light on the nature of oxide films on the surface of metal crystals [see also Abstr. 8341 (1951)].

H. J. H. STARKS

GEOPHYSICS 55

550.2

4043. Origin of the earth. H. JEFFREYS. *Nature* [*Lond.*] **169**, 260–1 (*Feb.* 16, 1952).

Short review of the paper by H. C. Urey on "The origin and development of the earth and other terrestrial planets," in *Geochimica et Cosmochimica Acta*, **1**, 209 (1951).

550.341

4044. Vibration measuring equipment with electronically variable constants. F. GASSMANN AND M. WEBER. *Mitt. Inst. Geophys. E.T.H. Zurich, No.* 16, 4 *pp.* (*June*, 1951). Also in *Verh. Schweiz. Naturforsch. Ges.* [*Davos*] (1950) *In German.*

This is a mathematical paper in which the constants of the equation for the displacement of the moving part of a mechanical seismograph are considered and transformed into the electrical characteristics of electronic amplifiers and recording equipment fed by signals from an electrical pick-up. No details are given of electrical circuits. A. C. WHIFFIN

550.37 : 538.566

4045. The magnetic dipole over the horizontally stratified earth. J. R. WAIT. *Canad. J. Phys.*, **29**, 577–92 (*Nov.*, 1951).

The behaviour of a small current-carrying wire loop over a horizontally stratified earth is investigated. The layers are considered to have a contrast in conductivity and dielectric constant only. Both harmonic steady-state and step-function current sources are considered. A.

550.384.3

4046. Remanent magnetism of rocks and the history of geomagnetic field. J. HOSPERS. *Nature* [*Lond.*] **168**, 1111–12 (*Dec.* 29, 1951).

Measurements were made of the remanent magnetism of 22 samples of igneous rocks taken from 2 series of lava-flows in Northern Iceland, a lower Tertiary series, of thickness about 3 000 metres, and an upper Quaternary series of about 200 metres. The Quaternary rocks and the older Tertiary were found to be normally magnetized, but the intermediate Tertiary were inversely magnetized. An inversion due to tectonic dislocations appears unlikely and it is concluded that an inverted geomagnetic field existed in Iceland for at least 25 000 years in Tertiary times. A. T. PRICE

550.837.3

4047. Some new developments of the geoelectrical resistance method. A. HUBER. *Elektrotech. u. Maschinenb.* [*EuM*] **69**, 1–10 (*Jan.* 1, 1952) *In German.*

A theoretical paper on the interpretation of experimental results in terms of structure of the earth's surface. The two- and three-layer problems are examined and then the theory is extended to several more difficult problems including a layer with continuously varying resistivity and special problems met with in mountain valleys and mines. The Schlumberger and Wenner methods of electrode spacing are discussed and it is shown that the further apart the potential electrodes are the smaller the variation in measured resistivity due to surface irregularities. J. M. HOUGH

550.93

4048. On a new method for determining chemical age by the lead method. F. G. HOUTERMANS. *S.B. Heidelberg Akad. Wiss.* (*Math.-Naturwiss. Kl.*) *No.* 2, 16 *pp.* (1951) *In German.*

The specific activity of Pb is used to determine the ratio RaD/end-product Pb, and thence the chemical age of pitch blendes from Katanga and St. Joachimsthal and of radioactive-Pb from Katanga. Measurements of the activities of RaE and RaF enable the RaD equivalent to the U present to be obtained. Analogously, the Th content may be obtained from the ThB as determined. Details of the methods of chemical separation and activity measurements are given. The method has the advantage that it may be used for very small amounts of radioactive minerals. J. GRANT

550.93

4049. Estimation of the age of calcite deposits by radioactive carbon. H. W. FRANKE. Note in *Naturwissenschaften*, **38**, 527–8 (*No.* 22, 1951) *In German.*

Rain containing CO_2 dissolves $CaCO_3$ to form $Ca(HCO_3)_2$: on evaporating and heating, $CaCO_3$ is again formed, and will contain $\frac{1}{2}$ the C^{14} content of the surrounding atmosphere. It should thus be possible, by C^{14} analysis, to date specimens of $CaCO_3$ so formed, up to $\sim$ 10 000 yr. A. O. STANESBY

ATMOSPHERE . METEOROLOGY 551.5

551.508.19 : 551.510.535

4050. A high precision ionosphere sounding equipment. B. M. BANERJEE AND R. ROY. Letter in *Sci. Cult.*, **17**, 305–6 (*Jan.*, 1952).

Fifty kW, pulses 8–30 μsec duration, wide band receiver, triggered raster time base [Abstr. 3968 (1951)]. The receiver incorporates a frequency discriminator to offset the wide band caused by the short pulse. An accuracy of height measurement of better than 1 km is attainable. No circuit or observational details are given.

551.508.99 : 551.510.535

4051. Certain improvements to an ionosphere recorder of the Berkner–Wells–Seaton type. E. HARNISCHMACHER. *Ann. Geophys.*, **7**, 262–4 (*No.* 4, 1951) *In French.*

The improvements described include the elimination of cam mechanisms and the use of rhombic aerials. W. J. G. BEYNON

551.508.99 : 551.510.535

4052. A new ionosphere recorder. K. BIBL. *Ann. Geophys.*, **7**, 265–7 (*No.* 4, 1951) *In French.*

Description of an improved recorder in which the

e usually involved in wave-change switching is inated. W. J. G. BEYNON

551.508.99 : 621.396.9 : 016

53. Selective annotated bibliography on radar as plied to meteorology. W. NUPEN. *Meteorolog. str.*, **2**, 680–1 (*Aug.*, 1951).

Subject matter is limited to applications of radar microwave equipment to observation of meteorological elements, excluding most articles which deal h the applications of meteorology to microwave dio or radar) transmission or to applications of crowave techniques to sounding of the ionosphere stratosphere. A.

551.510.535

54. Comments concerning the paper "Fine ucture of the lower ionosphere" by R. A. Helliwell, J. Mallinckrodt and F. W. Kruse. R. J. NERTNEY. tter in *J. Geophys. Res.*, **56**, 449–51 (*Sept.*, 1951).

In the earlier paper [Abstr. 6634 (1951)] the variation in level of reflection of long waves from the wer side of the *E*-layer was interpreted as evidence r stratification. An alternative explanation involving the critical collisional frequency and coupling offered. W. J. G. BEYNON

550.510.535

55. A note on certain characteristics of the rmal *E*-layer. C. H. GRACE. Letter in *J. Geophys. es.*, **56**, 452–4 (*Sept.*, 1951).

Evidence is presented showing that the diurnal ariation in the true height of maximum ionization r the *E*-layer only follows Chapman theory for eriods of about one hour near sunrise and sunset, nd also that within the *E*-layer the recombination efficient is pressure-dependent. W. J. G. BEYNON

551.510.535

56. A note on ionospheric wind measurements at 50 kc/s. G. H. MILLMAN. *Ann. Geophys.*, **7**, 272–4 (*No.* 4, 1951).

The results of some radio measurements of ionospheric winds made during July and August, 1951, are iven. W. J. G. BEYNON

551.510.535

57. Light-inadequacy of the ultraviolet theory of nization in the E-layer. E. F. GEORGE. *J. Franklin nst.*, **252**, 493–500 (*Dec.*, 1951).

From the reports of the CRPL, average yearly alues of h'_E, h'_{F1}, f°_E and N_{F1}, for the months of anuary, March, June, July, September and December f the years 1944 to 1949 were computed and plotted gainst the magnetic latitude. Altogether some 5 000 individual records were averaged. Seven urves were plotted. They showed that: (1) all curves re symmetrical with respect to the magnetic equator; 2) the h'_E, h'_{F1}, f°_E and the N_F curves all swing up and down as the magnetic latitude, north and south, increases; (3) the h'_E is definitely periodic with constant period and constant amplitude; (4) the h'_E curve rises only slightly (on the average) with latitude. These results appear to be inconsistent with the ultraviolet light theory of ionization. A.

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 3740–3

551.510.535 : 621.396.11

4058. The variation in the time received by radio signals. A. STOYKO. *Ann. Franç. Chronom.*, **6**, 193–202 (*No.* 3, 1951) *In French.*

The seasonal variation in the transmission time of transatlantic radio signals and the diurnal variation in the frequency of signals from WWV are discussed in relation to the known variations in the ionosphere. W. J. G. BEYNON

551.521.3

4059. Atmospheric absorption of solar radiation. R. ANTHONY. Letter in *Phys. Rev.*, **85**, 674 (*Feb.* 15, 1952).

Within the i.r. region, 1·5 to 20 μ, absorption coeffs. and solar intensities for 8 different λ values are graphed as functions of frequency and precipitable water vapour. Results are compared with those of Adel, and with Elsasser's computed values of α_ν. D. R. BARBER

551.578.4

4060. A bibliography on snow and ice. D. C. PEARCE. *Nat. Res. Coun. Can., Publ. No.* 2534, 69 *pp.* (1951).

551.578.4 : 538.566.2

Radar echoes from falling snow. *See Abstr.* 3737

551.593.5 : 523.38

4061. The influence of the atmospheric O_3 layer on the colour of the earth-shadow on the eclipsed moon. H. K. PAETZOLD. *Naturwissenschaften*, **38**, 544–5 (*No.* 23, 1951) *In German.*

The combined effects of Chappuis O_3 absorption and Rayleigh scattering in the visual spectrum are discussed in relation to the "green zone" observed in the umbra at several recent eclipses. D. R. BARBER

551.594.9

4062. Negative electric fields in the atmosphere. J. A. CHALMERS. Letter in *Nature* [*Lond.*] **169**, 336 (*Feb.* 23, 1952).

Investigations have shown that negative electric fields observed in mist and low stratus cloud at Durham were due to discharges at pylons of overhead high-tension power lines and travelling in the wind. With high humidity the effect may be observed several miles from the source. A current of negative ions of about 1 μamp. per pylon could produce the effects observed. R. S. READ

BIOLOGY 57/59

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

61 : 621.397.9

4063. Television in medicine and biology. V. K. ZWORYKIN AND L. E. FLORY. *Elect. Engng* [*N.Y.*] **71,** 40–5 (*Jan.*, 1952).

The value of the simple television camera, for transmitting events from the operating theatre, is known, and can be increased by using a double camera whose two recorded images are polarized in mutually perpendicular planes. A stereoscopic effect is then produced if the screen is viewed through "Polaroid" spectacles. Techniques employing the fundamentals of television include: (1) the study of heart and brain activity as revealed by the space- and time-variation of skin potentials (methods of presenting such potential patterns are described); (2) the X-ray image intensifier; and (3) the scintillation counter. The television microscope, a combination of an optical microscope and television receiver, is described at length. D. V. MABBS (R)

612.843.31

4064. The appearance of colors in twilight. W. E. K. MIDDLETON AND E. G. MAYO. *J. Opt. Soc. Amer.*, **42,** 116–21 (*Feb.*, 1952).

Sixty-four colours well distributed near the Munsell 6-plane were viewed as 2° squares surrounded by a 5° black square which was in turn surrounded by a large area of Munsell *N*6/. The colours were viewed in random order at luminances of $-3{\cdot}34$, $-2{\cdot}86$, $-2{\cdot}37$, $-1{\cdot}88$, $-1{\cdot}38$ and $-0{\cdot}88$ log candles/m^2, the illumination being at a colour temperature of about 6 500°K. The observer was required to signal by means of a switch whether he observed red, orange, yellow, green, blue, purple or grey. No time limit was imposed. Sixteen sets of observations were made by each of two observers, eight sets by a third observer. All had normal colour vision. At the lowest luminance only occasional observations of purple were reported, nearly all colours appearing grey. As the luminance was raised, purple appeared first, then blue. The colours along an axis from about 7·5GY to 2·5P required the greatest illumination to appear chromatic. These results show an interesting correspondence with those of Middleton and Holmes on the appearance of colours subtending small angles. A.

612.843.53

4065. The scintillation of stars. D. G. DHAVALE. Letter in *Sci. Cult.*, **17,** 88–9 (*Aug.*, 1951).

Support is presented for a physical explanation of this phenomenon, since an out-of-focus point source of light gives rise to a more marked scintillatory effect in the eye than when it is focused properly.

R. A. WEALE

612.843.611

4066. A proposed method for predicting light adaptation. R. H. PECKHAM. Letter in *J. Opt. Soc. Amer.*, **42,** 65 (*Jan.*, 1952).

Hulburt's data [Abstr. 6660 (1951)] are used for the construction of a curve in which the time in min, required for adaptation to darkness after "a standard exposure to light of various wavelengths," is plotted against the wavelength. The curve is maximal at $\lambda = 0{\cdot}46\ \mu$, showing that this is the most effective wavelength for light adaptation. Interpolation in these calculated data yields values for the light adaptation (expressed in arbitrary units).

R. A. WEALE

612.858.7

4067. The jaw motions relative to the skull and their influence on hearing by bone conduction. E. K. FRANKE, H. E. VON GIERKE, F. M. GROSSMAN AND W. W. VON WITTERN. *J. Acoust. Soc. Amer.*, **24,** 142–6 (*March*, 1952).

Opening and closing the mouth increases the sound pressure produced by bone conduction in the closed auditory canal by as much as 6 to 10 decibels in the frequency range between 40 c/s and 700 c/s. This difference is explained by vibrations of the lower jaw relative to the skull. The resonance curve of this motion was measured and used to calculate the influence of the lower jaw motion on the sound level in the closed auditory canal. The results show that the measured frequency response of the difference in sound pressure open mouth *v.* closed mouth may be explained entirely by vibrations of the lower jaw. A.

612.858.71

4068. The dynamics of the middle ear and its relation to the acuity of hearing. H. FLETCHER. *J. Acoust. Soc. Amer.*, **24,** 129–31 (*March.*, 1952).

The transformer action of the middle ear as measured by Bekésy is shown to be the principal cause for the low acuity of hearing for low frequencies. Because of the very low mechanical impedance across the basilar membrane at low frequencies, large acoustical pressures in front of the ear drum produce appreciable acoustical pressures across the basilar membrane. For example, at 100 c/s this pressure is 30 times and at 6 000 c/s it is $\frac{1}{10}$ that created across the basilar membrane. A.

612.858.73

4069. Some statistical aspects of half-loudness judgments. W. R. GARNER. *J. Acoust. Soc. Amer.*, **24,** 153–7 (*March*, 1952).

Half-loudness adjustments have been obtained from 18 observers at 10 intensity levels from 10 to 100 db. Adjustments were made with two methods. An analysis of variance of the attenuation scores necessary for half-loudness showed: (1) Intensity accounted for a quarter of the variance. This variance indicates the extent to which the attenuation necessary for half-loudness varies with different intensities. (2) Consistent differences between observers accounted for 35% of the variance, indicating that some observers consistently require much greater or less attenuation for half-loudness than others. (3) One-tenth of the variance was a result of the fact that the shape of the half-loudness function with respect to intensity was different for different observers. (4) The error variance, caused by repeated adjustments by the same observer at the same intensity and with the same method, was 22% of the total. (5) Other

nces were practically insignificant. The average loudness function differs markedly from pre-sly reported results. It is suggested that this epancy, as well as the large differences between riduals, is largely a result of the fact that observers difficulty establishing the correct fractional e, and thus are extremely susceptible to indirect estion. A means of avoiding this problem of a valid fraction is suggested. A.

612.858.74

1. The masking and pitch shifts of pure tones abrupt changes in a thermal noise spectrum. WEBSTER, P. H. MILLER, P. O. THOMPSON AND V. DAVENPORT. *J. Acoust. Soc. Amer.*, **24**, 147–52 *rch*, 1952).

hen a pure tone is mixed with a noise of uniform trum, its threshold is raised. At levels above shold, its loudness and pitch are changed by the ence of the noise. Introducing abrupt changes in slope of the noise spectrum by filtering out cting) one octave changes these effects in the nity of this gap. The masked threshold for a tone varies from the value for unfiltered noise at edges of the gap to a value approximately 25 db r at the middle. This indicates that gapped-e may be used to mask out sounds outside of the without unduly raising the threshold of sounds he gap. Presence of white noise generally raises pitch of a pure tone whose frequency is between and 4 000 c/s. Presence of noise with the gap s not raise the pitch of a pure tone located in the er half of the gap. For a tone located in the er half of the gap, the pitch is raised more than ould be in the presence of unfiltered noise. The nges in the judged loudness of pure tones partially ked by a gapped-noise reaffirm the importance of tails of the excitation pattern in their effect on dness. A.

612.858.76

1. Recovery of the auditory threshold after ng acoustic stimulation. I. J. HIRSH AND W. D. RD. *J. Acoust. Soc. Amer.*, **24**, 131–41 (*March*, 2).

fter an ear is exposed to an intense sound, the olute threshold for many sounds is raised, usually porarily. The manner in which the absolute shold recovers to its normal value after such nulation is the subject of these experiments. It is nd that recovery from such auditory fatigue is a simple monotonic process. Rather these eriments show that under certain conditions the shold first recovers to an approximately normal ie about 1 minute after the cessation of the ex-ure but then rises again to a higher value that ches a maximum at about 2 minutes after the osure. This diphasic recovery curve, with its racteristic "bounce," is found when the exposure olves sound pressure levels between 100 and 120 db l durations of the order of several minutes. covery curves are shown for the auditory thresholds clicks, bands of noise, and pure tones. Fatiguing nuli include bands of noise and pure tones. Two sidiary observations are also reported. First, in ny recovery curves there is evidence for a second ounce" or rise in the threshold after stimulation. Second, after stimulation by moderate intensities the initial recovery (about 1 minute after stimulation) may demonstrate facilitation, i.e. a temporary reduction in the absolute threshold below the normal value. Qualitative observations concerning the pitch and timbre of the test stimuli and of tinnitus following stimulation are related to some of the data. A.

612.858.76

4072. Comfortable listening levels for pure tones in quiet and noise. I. POLLACK. *J. Acoust. Soc. Amer.*, **24**, 158–62 (*March*, 1952).

The most comfortable listening level and the range of comfortable listening levels for pure tones were determined for a group of normal (non-clinical) listeners in the quiet and against various levels of background noise. In general, the most comfortable listening (m.c.l.) level contour has the general shape of the equal-loudness contour at intermediate loudness levels—lowest intensity at the middle frequencies and highest intensity at the lower frequencies. The range of listening levels considered "comfortable" against a quiet background varies from about 20 db at the lowest frequencies to about 35 db at the middle frequencies. The variability of the m.c.l. is larger at high frequencies than at low frequencies, and it is about the same magnitude as the variability of heterophonic equal-loudness matches. The effect of noise is primarily to raise the lower limit of the range of comfortable listening levels and only secondarily to raise the upper limit. As a result, the range of comfortable listening levels is decreased in noise. The possible use of the comfortable listening level test as a gross diagnostic tool in the detection of nerve-type deafness is discussed. A.

612.858.76

4073. Acoustical determinants of audiogenic seizures in laboratory mice. H. FRINGS AND M. FRINGS. *J. Acoust. Soc. Amer.*, **24**, 163–9 (*March*, 1952).

Albino mice were tested for susceptibility to audiogenic seizures in sound fields of various frequencies and intensities. An attempt to fix the ears of the mice with respect to the sound source by suspending the mice with a large spring clip which grasped the dorsal skin-fold proved fruitless, for too few seizures were induced at any intensity. The mice were therefore tested in a small wire mesh cage suspended in front of the sound-transducer, and the positions of their ears during the treatment were recorded. At 10 kc/s, at least 92 db was needed to induce seizures in mice which had no previous seizures, while only 83 db were needed for animals which had previous seizures. The most effective frequencies for the induction of seizures were between 12 and 25 kc/s. Below 10 kc/s the effectiveness dropped off sharply and was very low at 5 kc/s. Studies were not made above 25 kc/s. The peak of the mouse's audiogram is probably near the frequencies which are most effective for induction of seizures and is thus a little lower than that of the rat and about 1·5 octaves above that of man. The ability of mice to hear at frequencies which are ultrasonic for the human ear is probably the reason for the intense reactions of mice to complex sounds which seem of moderate intensity to man. A.

PHOTOGRAPHY 77

771.35

4074. On simple sky lenses. F. I. HAVLIČEK. Letter in *J. Opt. Soc. Amer.*, **41**, 1058–9 (*Dec.*, 1951).

This letter gives constructional data and an outline of the method of design of sky lenses, consisting of positive and negative components, covering the entire sky on a 24×36 mm format. R. W. FISH

771.534

4075. Spectral sensitivity of photosensitive acid resists. B. O'BRIEN, JR. *J. Opt. Soc. Amer.*, **42**, 101–3 (*Feb.*, 1952).

Several resins, both synthetic and natural, used as acid resists in photoengraving, are rendered photosensitive by the addition of alkali dichromates. The mechanism of this photosensitization is not entirely clear, and the spectral sensitivity of the reaction for widely different resins may be of aid in a study of the reactions involved. In addition, such sensitometric data are useful in the practical application of the resists. Al plates, coated with the resins, were exposed in a medium quartz spectrograph using a controlled White Flame arc and rotating logarithmic spiral sector to produce wedge spectra. Calibration of the spectral energy incident on the plate was made from 2 500 Å to the long wavelength sensitivity limit of the material at 5 000 Å. Spectral sensitivities for the several resins are qualitatively similar when expressed in terms of incident energy. Coating thicknesses are of the order of 1 micron. At this thickness only a fraction of the incident energy is absorbed, as shown by transmission spectra through similar coatings on crystalline quartz plates. A.

777 : 535.43

4076. Light scattering in halftone prints. F. P. CALLAHAN, JR. *J. Opt. Soc. Amer.*, **42**, 104–5 (*Feb.*, 1952).

Light scattering plays a part in determining the colours of a halftone print. By treating the print as a filter in contact with a scattering medium and ignoring second-order effects, approximate equations are derived which enable an upper limit to be set on the error resulting from the use of the Neugebauer equations in the usual way. The error is found to be no more important than the other errors associated with their use. A.

778.31 : 539.27

4077. Direct printing of shadowed electron micrographs. R. M. FISHER. Letter in *J. Appl. Phys.*, **23**, 153–4 (*Jan.*, 1952).

It is pointed out that the need for a double-process technique in making reproduction of shadowed electron micrographs can be eliminated by the use of a reversing paper. Details and examples are given. J. THEWLIS

778.3

4078. Particle tracks in nuclear emulsions. A. BEISER. *Amer. J. Phys.*, **20**, 124–33 (*March*, 1952).

After a brief survey of the properties of nuclear emulsions, the production of tracks in them by ionizing particles is discussed. The various techniques in use for determining the charge, mass and energy of the particles are reviewed, with the interpretation of grain density, track range, δ-rays and multiple scattering measurements described. Lastly consideration is given to auxiliary methods for neutron detection and the magnetic deflection of particles between emulsions. A.

778.33 : 539.166

4079. Memorandum on gamma-ray sources for radiography. *London: Institute of Physics* (1952) 23 *pp.*

This memorandum, prepared by a committee of the Industrial Radiology Group of the Institute of Physics, offers a brief account of the various γ-ray sources available for radiography, particular reference being made to sources supplied by A.E.R.E. Harwell and R.C.C. Amersham. Information is given on units, physical characteristics, radiographic technique and protection, among other items. Estimates of the cost of installing the necessary equipment for γ-ray radiography are also given, and lists, with prices, are appended of the kinds of source available with their half-lives and energies, and with exposure curves and activation-time graphs for the pile-prepared isotopes Co^{60}, Ta^{182} and Ir^{192}. Similar data with exposure curves, are given for Ra and Rn.

J. THEWLIS